

BIOLOGY AND CONTROL OF AQUATIC NUISANCES IN RECREATIONAL WATERS



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ABSTRACT

The control of aquatic nuisances has been in effect in Wisconsin since the early 1900's. Algae populations that have become so expanded that they contribute odors and unsightly conditions are temporarily abated through the use of copper sulphate. This chemical quickly reacts with natural carbonate ions in the water and precipitates into biologically inactive copper carbonate.

Nuisance growths of higher plants have been controlled both mechanically, with commercial weed-cutting equipment, and chemically, first with sodium arsenite and then beginning in the early 1960's with organic herbicides.

Organisms which cause swimmers' itch occur in many lakes throughout the state. Treatment of such lakes has consisted of annual applications of copper sulphate along relatively small areas of beach or shoreline.

Records have been systematically kept since 1950 on the use of chemicals in the control of aquatic nuisance growths on Wisconsin recreational waters.

**BIOLOGY AND CONTROL
OF SELECTED AQUATIC NUISANCES
IN RECREATIONAL WATERS**

By

Lloyd A. Lueschow

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INTRODUCTION

Wisconsin lakes have been formed under a wide variety of chemical and physical conditions. Some are deep and others shallow, some are in igneous rocks, some in sedimentary rocks, and some in glacial drift. Essentially all lakes have an inherent "age," dictated by features of the basin and water quality. But lakes are seldom static. They pass through several recognizable stages in an aging process known as eutrophication which specifically relates to the accumulation of plant nutrients. A lake with low concentrations of plant nutrients is infertile and relatively unproductive. This type of lake is described as oligotrophic. As time passes, a lake progresses from a low nutrient oligotrophic condition to a nutrient-rich, eutrophic condition. This nutrient change brings about subsequent changes in biological composition which affect the recreational use potential of a lake.

NUTRIENT SOURCES

There are at least three basic nutrient sources. Surface water drainage is perhaps the most important since it carries not only sewage and sewage effluents but farm drainage, fertilizer runoff, storm sewers and industrial waste directly to surface waters. Sewage and sewage effluents have long been a target of nutrient abatement efforts because even a well-operated sewage plant probably removes only one-third to one-half of the available nitrogen and phosphorus in raw sewage. When one considers that treated sewage effluent retains approximately 10 parts per million of total phosphorus and approximately 20 parts per million of inorganic nitrogen, it is apparent that where these effluents reach lake waters they are a major source of nutrients. Industrial waste sources also may be significant nutrient sources: wastes from milk plants, canning factories, and even pulp and paper mills.

Barnyard drainage is apparently as significant a nutrient source as raw sewage when it reaches surface waters. General farm drainage from crop and pasture lands is more difficult to evalu-

ate since the contributions are dependent on climatic conditions, soil types, physical features and many other variables.

Municipal storm sewers usually discharge directly to surface waters. This discharge has a relatively high nutrient concentration from sources such as lawn fertilization, debris accumulations, soil losses and numerous other chemicals. Sanitary sewers usually have overflow connections to storm sewers. During periods of heavy runoff, surface and ground waters enter the sanitary sewers, exceeding their capacity and causing overflow of raw sewage into the storm sewer system with direct discharge to surface waters.

A second major source of nutrients to surface waters is directly from the atmosphere. This is a major source of available nitrogen compounds but is probably not a significant source of phosphorus. Precipitation from the atmosphere is principally composed of "rained out" compounds but may also include dust and wind-blown debris which originate on land. Studies conducted on nutrients in rainfall suggest in a latitude like Wisconsin with approximately 30 inches of annual rainfall, one might expect 10 pounds per acre of nitrogen from atmospheric sources exclusive of dust and wind-blown debris. This would be comparable to the nitrogen contribution from one person per year in the form of raw sewage nutrients.

Ground water is the third major source of nutrients and reflects the availability from natural sources as well as man-induced sources. As water percolates through soil, it leaches soluble substances which are carried into the ground water. Nitrates, being readily water soluble, are easily transported by ground water. Phosphorus forms insoluble complexes with iron, aluminum, and calcium compounds and these compounds are not readily transported in ground waters. It is likely that septic tanks that operate well as soil absorption systems contribute nitrates (approximately 8 pounds of nitrogen per person per year) to the ground water, but the phosphorus (approximately two

pounds per person per year) is retained in the immediate vicinity of the septic tank. A disposal unit that overflows to the surface may contribute both nitrogen and phosphorus compounds.

Nutrients are also available from numerous other sources but the impact is more difficult to evaluate. Waterfowl contribute nutrients to a lake and one study has suggested that the contribution from eight ducks is comparable to one person. Marsh drainage contributions are probably high in nitrogen but relatively low in phosphorus. Perhaps one of the least understood sources of nutrients is the bottom ooze itself. During the winter months when standing crops are low, the nutrients tend to precipitate by various processes into the bottom muds. In summer, as growths utilize the available nutrients in the water, some of the nutrients in the bottom ooze are partitioned back into the water and again made available for growth. Regardless of whether the nutrient source was a "classical" pollution source or pollution from natural sources, the results of nutrient accumulation are the same. Nuisance growths of weeds and algae in surface waters are the resultant normal expression of a high nutrient status or eutrophic water.

OUTLOOK FOR EUTROPHICATION CONTROL

In general, efforts to control the accumulation of nutrients and thus reduce nuisance growths have not been technologically feasible. There have been extensive efforts to reduce nuisance growths by sewage diversion. This has been an effective preventive, but in highly eutrophic lakes where overabundant plant growth has already developed, the diversion of nutrients has not abated the nuisance condition. Although research is currently underway to work out methods for reversing eutrophication, economically feasible methods are not yet available to actually abate nuisance developments. Until such control is possible, those interested in managing water resources are left only with the possibility of symptomatic treatment.

ALGAE

BIOLOGY

In Wisconsin surface waters, relatively few genera of algae develop to the point of becoming an economic nuisance. The planktonic blue-green algae, a few genera of filamentous green algae, and *Chara* most frequently require nuisance abatement in Wisconsin waters.

The blue-green algae (Cyanophyta) and specifically the genera *Anabaena*, *Aphanizomenon*, and *Anacystis* are most often responsible for the unsightly nuisance "blooms" and odor that develop in Wisconsin lakes during the summer months. An algae "bloom" is most often defined as an unusually large number of algae units (cells or colonies or filaments) that are visually noticeable as a green or blue-green color or as they produce turbid waters. Lackey (1949) arbitrarily defined a bloom as 500 individuals per ml of raw water. Lueschow et al. (1969) suggested that noticeable algae conditions occur when the plankton exceeds 500 µg/l total solids when captured in a standard 20-mesh plankton net. Fitzgerald (1966) indicated a "heavy bloom" in lakes as 5-10 mg/l of solids.

Typically shoreline areas accumulate windrows of algae which often become so thick one cannot see the water. During these unusual accumulations, the algae is typically associated with a blue-colored bacteria (*Chromatium okeni*). The algae and bacteria appear so blue that it is often referred to as a "paint pot" condition. Under these conditions, the oxygen demand is often sufficient to reduce the dissolved oxygen levels in the water to zero and produce fish kills or the algae may release metabolic toxins such that the water is unsafe for both wild and domestic animals.

There are numerous recorded instances of toxic algae in surface waters (Gorham, 1960). Although it is generally felt that most of the blue-green algae species are capable of the phenomenon, it appears to be relatively rare in Wisconsin waters. These conditions have been recorded on Lake Delton, Sauk County, (Lueschow, 1967) and on Lake Mendota (Mackenthun et al., 1945). It is likely

that many cases of toxic blue-green algae are not recorded since users view the water as uninviting and animals will drink it only if there is no other water source available to them.

As with an agricultural crop, a host of nutrients are essential for the development of blue-green algae. In general, most of the nutrient substances are required in such minute concentrations that all surface waters are able to provide ample quantities. Inorganic nitrogen and ortho-phosphates are most usually considered limiting. Sawyer (1947) in an investigation of southeast Wisconsin lakes observed that lakes which had at least 0.3 parts per million of total inorganic nitrogen (NH₃-N, NO₂-N and NO₃-N) and 0.015 mg/l of soluble phosphorus could be expected to produce blue-green algae blooms during the ensuing summer. Lueschow et al., (1969) observed in twelve Wisconsin lakes that when the annual mean concentration of total inorganic nitrogen concentration was less than 0.3 mg/l, algae blooms were only local or nonexistent (Table 1). The same lakes which revealed algae blooms also had an annual mean concentration of total phosphorus of over 0.6 mg/l.

In general, the blue-green algae pop-

ulation during the winter months does not pose nuisance conditions for two basic reasons. First, the physical conditions of temperature and light are far from optimum, and secondly, the recreational demand on water during the winter months is not nearly as great. Swimmers and boaters are comfortably relocated; the ice fisherman is still plying his trade but associates himself with a rather limited view of the water. The ice fisherman, however, does note an occasional bloom of a blue-green algae known as *Oscillatoria rubescens*. This particular species appears red and has the capacity to develop at the low winter temperatures and the reduced light intensity. There has been no effort made to control this species in Wisconsin waters during the winter months.

As the spring water temperature increases, the blue-green algae population generally expands and in eutrophic lakes may develop to nuisance conditions quickly and remain a nuisance during the entire summer. Some feature of their physiology or physical environment, however, apparently prohibits further expansion. Even in sewage stabilization ponds, where there is no lack of nutrients, the blue-green algae populations do not expand indefinitely. Unfortunately, these natural population checks do not exercise their influence until after the algae have already become a nuisance to recreational lake users.

As a means of evaluating the plankton population in terms of nuisance conditions, Lueschow et al., (1969)

Windrow Accumulations of Planktonic Blue-Green Algae. (Round Lake, Burnett County)



TABLE 1. Trophic Rank of Twelve Wisconsin Lakes Based on Seven Parameters.

	Dissolved Oxygen	mg/l 1 M. Off Hypolimnion Bottom	Plankton No. 20 Mesh Net	µg/l Total Solids	Transpar- ency Secchi Disc	Sea- sonal Mean	Organic Nitrogen mg/l	Mo. Mean mg/l	Total Inorganic Nitrogen	Mo. Mean mg/l	Soluble Phosphorus	Mo. Mean mg/l	Total Phosphorus	Mo. Mean mg/l
Most Oligotrophic ↑	Big Green	8.1*	Round	60.3	Crystal	7.7	Crystal	.162	Crystal	.124				
	Crystal	3.15	Pine	64.5	Big Green	5.4	Trout	.251	Geneva	.170	Round	.014	Crystal	.027
	Trout	1.9	Crystal	68.0	Geneva	4.6	Big Green	.358	Trout	.176	Crystal	.018	Geneva	.041
	Geneva	1.0	Geneva	77.5	Middle	4.4	Geneva	.379	Pine	.210	Geneva	.018	Big Green	.051
	Round	0.15	Trout	81.7	Oconomowoc	4.4	Oconomowoc	.460	Big Green	.245	Trout	.018	Trout	.053
			Big Green	83.4	Trout	4.1	Round	.495	Middle	.263	Big Green	.027	Round	.057
	Oconomowoc	0.0	Middle	252	Round	3.9	Middle	.545	Oconomowoc	.276	Winnebago	.031	Winnebago	.129
	Pine	0.0	Oconomowoc	426	Mendota	3.1	Mendota	.614	Winnebago	.354	Mendota	.066	Mendota	.149
			Mendota	751	Pine	2.7	Pine	.663	Pewaukee	.421	Delavan	.075	Delavan	.170
			Pewaukee	1004	Delavan	1.6	Pewaukee	.827	Delavan	.470				
↓ Most Eutrophic	Mendota	0.0												
	Middle	0.0	Delavan	1637	Pewaukee	1.5	Winnebago	.982	Mendota	.579				
	Delavan	0.0												
	Pewaukee	0.0	Winnebago	2118	Winnebago	.7	Delavan	1.195	Round	.788				

*Middle of hypolimnion.

quantitated the plankton from 12 popular, recreational lakes that represented a broad range of trophic conditions (Table 1). Three of the lakes examined were more or less plagued with algae nuisances during most of the summer months. Lake Delavan had the most consistently high plankton level (approximately 2,500 µg/l), dominated by blue-green algae. The visual clarity on Delavan Lake was typically less than one foot (secchi disc). These conditions were clearly a nuisance to boaters and other recreational users all summer. Lake Mendota plankton populations were far more variable than on Lake Delavan and the nuisance conditions were more sporadic, usually associated with on-shore wind conditions. Other lakes such as Geneva and Trout did not reveal unusual algae populations during the summer months.

CONTROL

Control is necessary when algae populations become so expanded that they contribute odors and unsightly conditions. Such lakes are also routinely inhabited by rough fish which further add to the undesirable features of the lake. Currently chemical treatment is the only practical method of algae control. Chemical control is

merely a temporary nuisance abatement procedure, since at this time there are no mechanical control methods or methods for reversing or retarding eutrophication. Ultimate control will have to be brought about by nutrient removal.

Copper sulphate has been used for algae control since the early 1900's. In Wisconsin, it has been used since the mid-1930's and some lakes such as Monona and Waubesa have received hundreds of tons of this chemical.

When copper sulphate is applied directly to the surface algae, the chemical acts to interfere with vital physiological processes; often the algae cells turn grey shortly after treatment and decompose. Copper sulphate is also toxic to fish and fish food organisms at approximately one part per million. However, in the hard waters of Wisconsin the copper sulphate quickly reacts with available carbonate ions to precipitate as copper carbonate. Copper carbonate is biologically inactive when compared to copper sulphate—its threshold of toxicity approaches 50 parts per million. Once this conversion has taken place the chemical is no longer effective in algae control and no longer a danger to fish. Therefore, the nuisance algae located in the trophic zone relatively near the surface can be sprayed with one part

per million copper sulphate and be killed before chemical precipitation deactivates the chemical. It is then essentially only deactivated copper carbonate that is available to fish and fish food organisms.

The use of copper sulphate for algae control, however, is not without some risk to the general lake ecology. The difficulty is usually not from chemical toxicity but rather from the after effects of chemical application. The decomposition of nuisance algae in a shallow, warm lake may result in the depletion of dissolved oxygen and a resultant die-off of fish and lower organisms.

A second difficulty involves toxic algae. It is well established that accumulations of algae can trigger a metabolic or decomposition product that is highly toxic to fish and other animals. This condition, however, may develop as readily when no treatment has been conducted.

In general, copper toxicity and residues have not been responsible for any undesirable effects in Wisconsin waters. Copper residues appear to "drift" to the deepest portion of the lake where they are slowly covered by organic sediments and rendered unavailable to the biological community. Direct toxicity is avoided by the chemical precipitation and deactivation.

Type of Treatment

Algae control treatments may be marginal or complete. A complete treatment is generally used where the affected area is relatively small—e.g. water supply reservoirs, lagoons, channels, bays, ponds, and small lakes. The period of nuisance control is greatly increased by a complete treatment over a marginal treatment—up to 4 to 6 weeks of control on a small lake after a complete treatment.

A marginal treatment, on the other hand, is designed to obtain temporary relief from algae accumulations in shoreline and protected bay areas that are usually extensively developed by high value properties. The duration of freedom from algae nuisances following marginal treatment is governed by the rate of reinfestation from wind and wave action. Generally, marginal control is applied weekly or bi-monthly. The application is typically conducted on a 200 to 400 foot margin around a large lake where the wind-blown accumulations cause the nuisance conditions.

Equipment and Application

Copper sulphate is marketed as a granular material commonly known as "blue vitrol". The compound must, of course, be brought into solution before spraying since the application of granular material is difficult to control at the low dosages necessary. A diagram of the equipment most widely used in algae control is shown in

Figure 1. The power source is usually a 3 to 5 horsepower gasoline-driven, centrifugal, single unit pump. This type of unit has ample pumping capacity to deliver approximately 400 pounds of copper sulphate per hour as a 2 to 3 percent copper sulphate solution. The pump intake hose is at least 1½ inches in diameter, and the spray hose also is 1½ inches with a ½ inch nozzle to deliver a good spray pattern. A water return line to the chemical reservoir keeps the chemical soluble.

The speed of the treatment barge and the spray distance is taken into consideration when determining the quantity of material going through the nozzle. Usually the concentration at the nozzle can be determined reasonably accurately by the color of the spray solution. The blue color first begins to appear at about a 2 percent solution. If additional accuracy is desired, standard solutions can be developed at 1 to 5 percent $\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$. They are acidified slightly to prevent precipitation, but once they are set, the color standards are reasonably stable. Samples may then be collected from the reservoir return line and compared with the standards to determine the exact concentration of the application. Uniform and accurate distribution of the chemical is extremely important. Therefore, accurate maps of the treatment area are necessary so that a continuous back calculation can be made to evaluate the chemical applied.

Since copper sulphate is moderately

corrosive to metal pumping equipment, the equipment is cleaned thoroughly after use. Under normal operating circumstances, the extent of corrosion in equipment can be retarded to such an extent that equipment is usable for 6 to 8 years.

It is usually desirable to treat before the major algae bloom develops in order to avoid excessive decomposition of the algae which consumes so much dissolved oxygen. Marginal control does not normally deplete the dissolved oxygen, but for a complete treatment, no more than one-half of a lake is treated on any one day.

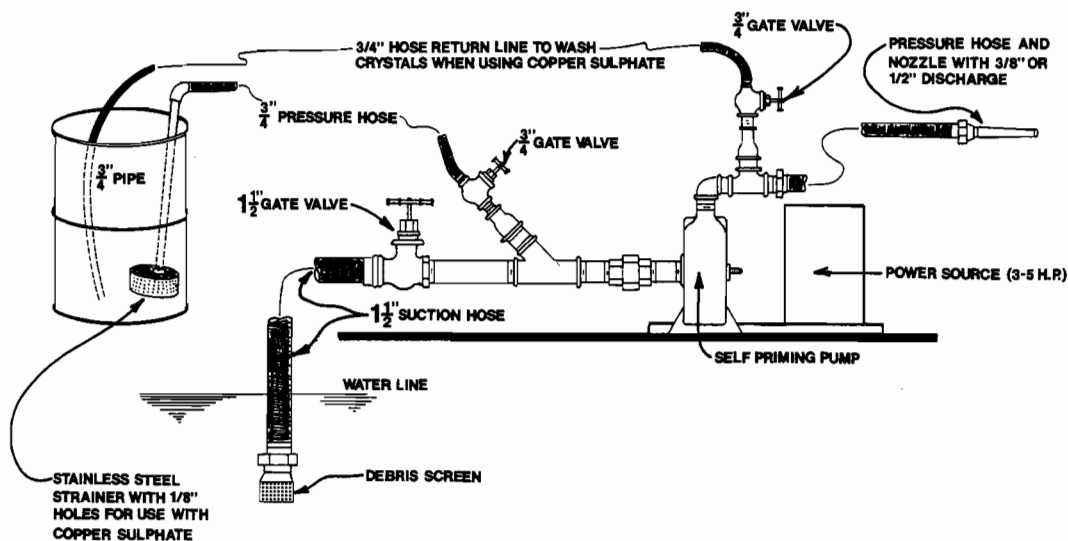
Although copper sulphate is not normally toxic to fish or fish-food organisms, spraying is generally arranged so that fish are not trapped in shallow treated areas. Normally the treatment is conducted from the shore toward open water with the spray passes made parallel to shore. The direct treatment of fish in live boxes or other traps is avoided.

Specific Measures

Blue-green planktonic algae: The most usual application for planktonic algae is 5.4 pounds copper sulphate per surface acre (one part per million for the upper two feet).

Filamentous Algae: *Cladophora* sp. and related greens are perhaps the most common types of attached filamentous algae producing nuisance growths in Wisconsin lakes. In general, the nutrient levels need not be as high

FIGURE 1. Equipment for Applying Chemicals for Weed and Algae Control Projects





Chemical Spraying Equipment used in Weed, Algae, and Swimmers' Itch Control Program.



Granular applying equipment. This relatively inexpensive equipment is used only on large projects. Areas of 10 acres or less are most usually treated by simple hand-broadcasting techniques.

in the media as for the development of planktonic forms. The filamentous varieties do not produce the highly turbid water of planktonic algae but cause distinct nuisance conditions in relatively clear lakes. The usual control procedure is through the application of copper sulphate at 10 pounds per surface acre. The application must

normally be repeated at weekly intervals for 3 to 5 weeks.

Chara: The application of copper sulphate for Chara control is usually at the rate of 10 pounds per acre and is applied as close to the bottom as practical to get the chemical directly to the plant before the conversion to copper carbonate. The chemical is

normally applied in early spring before the growths have had an opportunity to break free from their attachment and float to the surface. Three to five treatments are often necessary to achieve adequate control of these growths particularly in deep water.

Diatoms: Diatoms have occasionally been reported as nuisances and indeed have been treated on occasion. However, treatment procedures for the planktonic diatoms are similar to planktonic blue-green algae and attached diatoms are treated like Chara or filamentous greens.

Use on Wisconsin Lakes

Algae control on Wisconsin recreational waters is practiced only with copper sulphate. Between 1950 and 1969, 130 lakes have been treated at least one time (Table 2, App.). A total of 1,585,059 pounds of copper sulphate has been recorded. It is unlikely that significant quantities of copper sulphate are used for algae control without being recorded since equipment is relatively bulky and the operation is noticeable. The Madison lakes have received far more copper sulphate for algae control than any other state recreational waters and indeed, most of the copper sulphate applied to Lakes Kegonsa, Monona, and Waubesa was recorded prior to Department of Natural Resources record-keeping. Treatment of these lakes was essentially discontinued by 1954 in favor of other programs designed to reduce nutrients (sewage effluent diversion).

The Chetek Chain of Lakes in Barron County, Pewaukee Lake in Waukesha County, Nepco Lake in Wood County and Wapogasset Lake in Polk County, have all received over 100,000 pounds but all are relatively large lakes where algae control is confined to developed shoreline areas and conducted during the active growing season as necessary to prevent accumulation of growing and decaying algae. Half Moon Lake in Eau Claire County is unique in that it receives virtually a complete treatment weekly during the active growing season. In spite of this tremendous per acre application of copper sulphate, there appears to be no unusual side effects and there is no detectable copper in the water. The sediments reflect the presence of copper but there seems to be no apparent effect on the bottom organisms or fish.



An accumulation of filamentous green algae. These wind-blown accumulations continue to develop during the summer months and although they appear to be dried and dead, the underside of the clump shows the algae are still alive and represent an accumulation of several inches. (Lake Michigan, Manitowoc County)

HIGHER PLANTS

Aquatic plant growths are normal constituents of freshwater environments and it is only when the growths become excessive that they cause nuisance conditions and are collectively referred to as "weeds". The rooted plants which contribute to the majority of the nuisance conditions on Wisconsin recreational waters require not only nutrients and sunlight as with algae, but also the penetration of sunlight to the bottom where the growths begin. Naturally turbid or colored waters reduce the light penetrations so that the trophic zone is limited to much shallower water. Algae growths also reduce light penetrations and consequently, limit the water depth where higher plants can grow. In Wisconsin, there are numerous examples of this type of mutual exclusion. Lake Winnebago (Winnebago County) and Lake Delavan (Walworth County) are good examples.

Rooted plants are dependent on an acceptable bottom for attachment. The root system of aquatic plants is usually much less elaborate than terrestrial plants since the water medium both suspends the plant and provides the water and essential nutrients. The roots, therefore, function principally as a holding mechanism. The holding strength, however, is not nearly as efficient as that for terrestrial

plants and many environmental factors such as unusual wave action, boat waves and even gas formation in the bottom muds can free many varieties of aquatic plants so that they may drift and decompose or reestablish in a different location. Aquatic plants may also develop roots and establish from a cut portion of stem, such as might occur after nuisance removal by cutting or motor boat operation in weed beds.

BIOLOGY

Free Floating Plants

Free floating species such as lesser duckweed (*Lemna minor*) have a root system, but the short roots are not attached. Vegetative growth is initiated by lateral branching and ultimate separation into two separate plants. Free floating nuisances usually develop on relatively shallow, fertile waters. The nuisance conditions are typically worse near shorelines since the plants are easily windblown. Duckweed accumulations may also develop in open waters of a shallow lake where attached growths reach the surface and provide an entrapment mesh for the free floating plants.

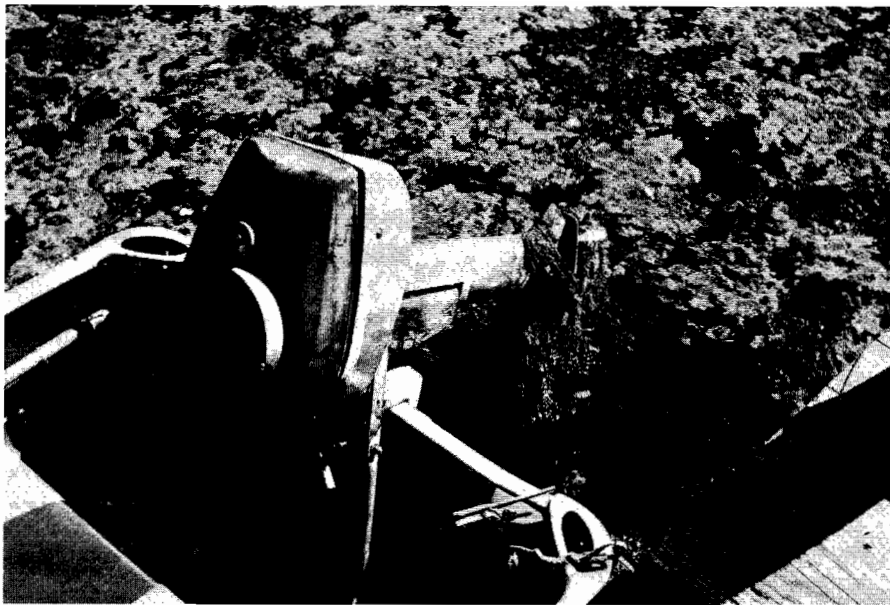
In Wisconsin, nuisance duckweed may be observed on Mirror and Delton Lakes (Sauk County) and on Onalaska

Lake (La Crosse County). Many other lakes have nuisance duckweed growths, but the condition is usually confined to limited shoreline areas. Wisconsin is fortunate to be free of the worst free floating nuisances, water hyacinth and alligator weed, which are prominent in southeastern United States.

Emergents

Emergent aquatics are rooted in relatively shallow water so that most of the growth occurs above the water line. They are spread by an underground root system and new emergent plants can occur almost anywhere in the network. Common examples of these growths are cattails (*Typha*), arrowhead (*Sagittaria latifolia*) and bulrushes (*Scirpus*).

The cattails and bulrushes are common on many Wisconsin recreational lakes. Generally the growths are confined to immediate shoreline areas, but occasionally they develop on several acres of shallow water. Arrowhead, on the other hand, is not as common a nuisance plant as cattail and bulrush, but where it does develop in relatively shallow lakes it often infests extensive areas. The emergent aquatics virtually destroy the water area for almost all recreational pursuits. Although there may be some value to wildlife asso-



Weed nuisances on recreational waters can develop to such an extent that typical recreational pursuits are virtually impossible.

ciated with these growths, most recreational pursuits such as boating, fishing and swimming are essentially eliminated in these areas.

Submergents

The pondweeds are one of the major subdivisions of submergent aquatics and belong mostly to the genus *Potamogeton*. They are distinguished from other submerged types in that they have a definite but diverse leaf form. The leaves vary from thin and threadlike to membranous and broad. Most of the *Potamogetons* have extensive root systems and runners so that new growths can develop vegetatively as well as from seeds.

One of the most widespread nuisance pondweeds is Sago pondweed (*Potamogeton pectinatus*). The plant has a much branched stem and threadlike leaves. It develops nuisance conditions in both hard and moderately soft water lakes. In clear waters, Sago pondweed is common to a depth of 10-12 feet. Curlyleaf pondweed (*Potamogeton crispus*), a common, membranous-leaved representative, is typically observed surviving through the winter months. It can develop distinct nuisance conditions early in the spring, disappear for a couple of months in early summer, only to develop new growths again in July and August. This growth pattern is also common of other species of *Potamogetons*, and positive identification is often essential to good control recommendations. These species are most commonly associated with rela-

tively clear waters and are observed to depths of 12-14 feet.

There is a taxonomically complex series of *Potamogetons* known as fine-leaved pondweeds. These species are characterized by grass-like leaves and usually inhabit shallow waters. The identification of the various species of fine-leaved pondweeds is difficult and in some growth stages is virtually impossible. However, the species distinctions are not usually important in control recommendations since they respond to control as a group and not independently.

Another type of submergent vegetation is characterized by no distinct leaf form. Water milfoil (*Myriophyllum*) and coontail (*Ceratophyllum*) are the most common representatives of this group. They are rooted but the root systems are typically not extensive so they break free readily and drift with the wind. Consequently, they may clutter a shoreline to the point where hand raking is the only removal method available. To compound the nuisance problems further, these plants have the ability to reroot from a cut stem or portion. Cutting without raking and removal can, therefore, produce a worse nuisance condition than originally existed. Motor boat usage in weed beds can also aggravate the situation and cause nuisance infestation where it did not originally occur.

Floating-leaved Plants

A fourth growth type includes the rooted plants with large, floating leaves. Some of the pondweeds fall

into this group, but most typical are the water lilies (*Nymphaea* and *Nuphar*) and American lotus. Lotus is protected in Wisconsin and it is illegal to initiate a control program without special authorization (Wisconsin Statutes 29.546). American lotus can be distinguished from common lily pads by the fact that the stem is attached to the middle of the leaf. Since the leaf of water lilies has a narrow deep incision, the stem is actually attached to the leaf edge.

CONTROL

Navigation interests were perhaps the first aquatic plant control practitioners to develop efficient weed removal equipment, but in recent years, hydrologists, game and fish management teams, as well as recreational interests, have all contributed to the development of practical control methods.

Mechanical Control

The earliest and simplest endeavors in aquatic plant control consisted of mere raking and pulling of the nuisance growths. Ultimate disposal involved hauling the plants to a land disposal site. Anyone who has practiced this type of control on a fertile lake is familiar with the effort necessary to relieve even a small area of nuisance weeds!

Other mechanical removal methods included the dragging of chains or bed springs through plant growths to dislodge them followed by collection and disposal. In recent years, aquatic weed-cutting equipment has been improved to the extent that the equipment simultaneously removes the plants from the water so they can be transported to shore and then disposed in an appropriate disposal site. This more elaborate equipment may process 400 tons per year of wet weeds (City of Madison experience). This equipment is much more efficient in deep, open waters than in shoreline areas.

The commercial cutting equipment now available generally cuts to a 4-foot depth. For greatest efficiency, it operates in such a way that the plants are transferred to a transport barge which carries them to shore and empties them onto a loader and truck for hauling to a suitable disposal site.

The entire operation requires substantial technical and operational support so that these operations are usually feasible only when under-

written by a municipality or strong cooperative agency.

The mechanical control of weeds is essentially not regulated by state or local agencies. The only pertinent regulation in Wisconsin concerning mechanical removal of aquatic plants identifies cut weeds as a nuisance and requires that they be removed (Wisconsin Statutes—Section 30.125). There is no permit necessary but specific legislation regarding specific plants and areas must be considered:

1. Section 29.544 concerned with wild rice preservation.

2., Section 29.545 concerned with aquatic weed protection in certain sections of the Wolf and Fox Rivers.

3. Section 29.546 concerned with the preservation of American lotus.

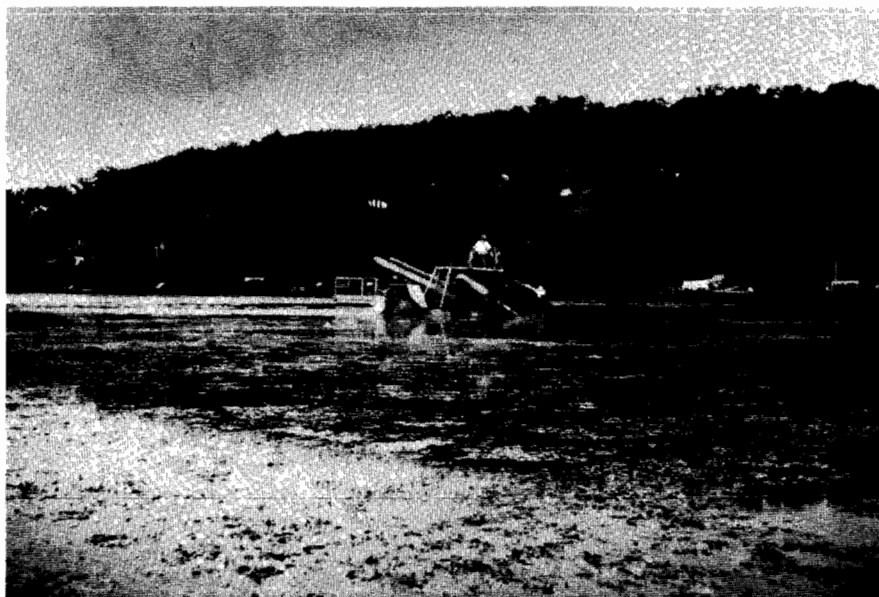
Chemical Control

The chemical control of aquatic plants is an outgrowth of comparable activities widely practiced in agriculture. Prior to the 1960's, the only product utilized in aquatic plant control was sodium arsenite, an agricultural herbicide. However, in the late 1950's, extensive investigations were initiated on the efficiency of other agricultural chemicals as well as products not used in agriculture. These products were all moderately biodegradable so that there was less potential accumulation of residues expected after repeated usage. Furthermore, the chemicals were carefully screened by both industry representatives and federal and state regulatory agencies to insure that at the effective use level there were no unusual hazards to resident fish populations or to other aspects of the lake ecology. Organic herbicides gradually replaced sodium arsenite in aquatic plant control activities. In 1961, Wisconsin lakes were treated with nearly 200,000 pounds of sodium arsenite; by 1965, this quantity had been reduced to 90,000 pounds; and by 1970 to zero.

The conditions for chemical use in the aquatic environment are substantially more restrictive than for agricultural uses. A commercial firm desiring to distribute a particular product must provide an extensive series of investigations and data in support of their request for federal and state use registrations.

An ideal aquatic herbicide must meet the following criteria:

1. Quick and efficient destruction of the nuisance plant.
2. Nontoxic (acute and chronic) to



Modern weed harvesters both cut and remove nuisance weeds.

other desirable aquatic organisms (fish, arthropods, etc.)

3. Nontoxic to water users.

4. Easy and safe to apply.

5. Readily confined to specific areas.

6. Breakdown to harmless products with no residue potential.

Only a very few aquatic herbicides have met the above criteria sufficiently to be accepted for use on recreational waters. There will be a continuing effort by industry and government to develop new products that more completely meet the use criteria listed.

Four aquatic herbicides are currently registered for general supervised use on Wisconsin recreational waters: 2,4-D, and Silvex (2,4,5-TP), diquat, and the salts of some endothal compounds marketed as Aquathol.

2,4-D

The common agricultural herbicide 2,4-D (2,4-dichlorophenoxy acetic acid), has proven to be an effective aquatic herbicide. It kills a plant by disrupting the pattern of cell division in the actively reproducing portion of leaf, stem, and roots. This type of hormone-killing action usually requires more time to effect a kill than do contact herbicides. Most 2,4-D applications are made in late May or early June and as long as 4 to 6 weeks may be required for the plants to die and go down.

2,4-D is commercially available as a salt or ester and the formulation utilized is usually dependent on where plant absorption will take place. Plant

roots absorb polar forms (salts) more readily, and leaves absorb nonpolar forms (esters) more readily. Since most absorption in aquatic plants is provided by the leaves, the 2,4-D esters are more widely used than the salts. There are a host of esters available for agricultural purposes, but only the iso-octyl ester (hexyl ethyl ester) is accepted by the Wisconsin Department of Natural Resources since this formulation possesses the least toxicity to aquatic fish and fish-food organisms.

The iso-octyl ester of 2,4-D is available from most agricultural chemical supply houses as either a liquid or granular formulation. It is most efficient in broadleaf plant control and has been used extensively in Wisconsin on the following species at 2 to 4 ppm of acid equivalent:

Water milfoil (*Myriophyllum* spp.)

Water Buttercup (*Ranunculus* sp.)

White Water Lily (*Nymphaea odorata*)

Yellow Water Lily (*Nuphar* spp.)

Coontail (*Ceratophyllum demersum*)

Willow (*Salix* spp.)

Best results are obtained when the application of 2,4-D is made at a time when the plants are actively growing. The treatment season in southern Wisconsin is typically late May and in northern Wisconsin, early June. The principal difficulty with 2,4-D is that with treatment this early, the cold water reduces the effectiveness, or, if control is achieved that early, regrowth of the nuisance weeds are apparent before the end of the recrea-

tional season.

The federal labeling of 2,4-D restricts water users in treated areas. Swimming is restricted for one day and other uses such as public drinking water, stock watering, and irrigation are restricted for three days. These restrictions are applicable only to the treated area and a relatively small marginal or buffer zone around the treated areas.

Silvex

Silvex (2,4,5-Trichlorophenoxy propionic acid), like 2,4-D, is a phenoxy compound that kills a plant by overstimulation of the meristem regions of the root, leaves, and stem. The material is marketed as a low volatile iso-octyl ester or potassium salt either in liquid or granular formulation. Silvex is seldom used alone as an aquatic herbicide but is more often used in combination with endothal compounds to give these products a broader spectrum by insuring translocation of herbicide to the root system and preventing regrowth after the stalk and leaves have been killed by the contact herbicide. Silvex is most widely used on the following species usually in combination with a contact herbicide:

Arrowhead (*Sagittaria* spp.)

Eelgrass (*Vallisneria americana*)

Elodea (*Elodea canadensis*)

Labeling restrictions on Silvex (2,4,5-TP) are the same as 2,4-D; one day restriction against swimming, and three days for other water uses.

Diquat

Diquat is a quaternary ammonia compound that is particularly safe to fish and fish-food organisms. It acts as a contact herbicide and is absorbed quickly by plant tissue effecting a rapid kill. Typically the treated weeds will be brown the day following treatment. The chemical is rapidly absorbed onto silt particles and is essentially deactivated. Turbid waters cannot be successfully treated because of this feature. Diquat is effective on

filamentous algae as well as a wide variety of plants. Since Diquat is a contact herbicide, it is most efficient on those plants without extensive root systems where the ability of the plant to initiate regrowth from the root is reduced. Diquat is used as a broad spectrum herbicide in Wisconsin recreational waters and is particularly successful on the floating plants. Plants controlled include:

Duckweed (*Lemna* sp.)

Eelgrass (*Vallisneria americana*)

Elodea (*Elodea canadensis*)

Potamogetons

Aquathol

The potassium salt of endothal (1,2-dicarboxy-3,6-endoxoxy cyclohexane) is perhaps the most widely used aquatic herbicide currently on the market. It was first used in Wisconsin waters in the early 1960's and has undergone extensive use evaluation. The material is marketed as Aquathol® and also as Aquathol® Plus, a mixture of endothal and silvex.

Endothal compounds are contact herbicides that cause the plants to die and go down 3 to 5 days after treatment. There is a wide margin of safety between the use rates and toxicity to desirable fish and fish-food organisms. The addition of silvex to the endothal effectively broadens the species spectrum and adds to efficiency by preventing regrowth from roots that are difficult to control with a contact herbicide.

The potassium and sodium salts are not the only formulations of endothal. The dimethylcocoamine derivation is even more effective in aquatic weed control but its high toxicity to desirable fish species prevents its use as an aquatic herbicide. The endothal compounds with silvex are perhaps the most broad spectrum aquatic herbicides currently on the market. Table 3 is a summary of these plants controlled with Aquathol as well as other currently acceptable products.

Use on Wisconsin Lakes

Control of higher plants on Wisconsin recreational waters between 1950 and 1960 was essentially practiced only with sodium arsenite. Typically, the treatment was sponsored by an organization or municipality rather than an individual since the application of the chemical was difficult and required experience and equipment to safely effect a good treatment. In the early 1960's, the organic herbicides came into prominence and it was possible to confine treatment to small areas by techniques available to every property owner. The potential of damage to desirable fish in these relatively small treatments with chemicals that displayed a wide margin of safety was almost nil and consequently, the regulatory agency relaxed the supervisory restrictions on these projects. The agency, however, did continue to record all chemical applications and Tables 4 and 5 (App.) summarize the chemical plant control activities between 1950 and 1969. It is unlikely that unrecorded sodium arsenite is a factor in this tabulation since the application required experience and equipment. However, it is probable that small quantities of the organics have been used by cottage owners without a Department of Natural Resources permit and subsequently, those applications do not get recorded. As will be noted from Table 4, the use of sodium arsenite declined between 1959 and 1968 until in 1970, it was totally discontinued.

By the same token, the organic herbicides increased between 1958 and 1969 but the pattern of treatment changed. Rather than relatively large treatments over extensive lake areas by strong sponsoring organizations, the treatments were designed to improve small areas for beach development and boat access by single property owners. A few large programs continued but even these programs developed more selectivity on treatment areas because of the cost factor associated with the organic herbicides.

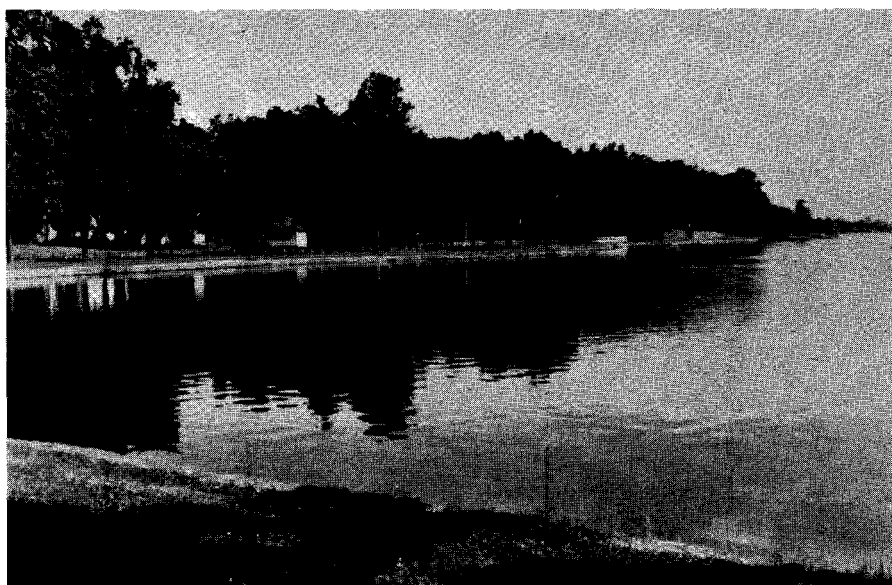
TABLE 3. Aquatic Weed Control with Organic Herbicides.

Aquatic Plant	Aqua. K	Aqua. +	Ortho Diquat	Iso-Octyl 2,4-D	Silvex-4# 2,4,5-TP	Potassium Silvex 6#	Hydro. 47
Largeleaf Pondweed							
<i>Potamogeton amplifolius</i>	C	C	NC	NC	NC	NC	--
Sago Pondweed							
<i>P. pectinatus</i>	C	C	C	NC	NC	NC	--
American Pondweed							
<i>P. nodosus</i>	C	C	CC	NC	NC	NC	--
Small Pondweed							
<i>P. pusillus</i>	C	C	C	NC	NC	NC	--
Floating Leaf Pondweed							
<i>P. natans</i>	C	C	C	NC	NC	NC	--
Waterthread Pondweed							
<i>P. diversifolium</i>	C	C	NC	NC	NC	NC	--
Flatstem Pondweed							
<i>P. zosteriformis</i>	C	C	NC	NC	NC	NC	--
Curlyleaf Pondweed							
<i>P. crispus</i>	C	C	C	NC	NC	NC	--
Narrowleaf Pondweed							
<i>P. strictifolius</i>	C	C	C	NC	NC	NC	--
Claspingleaf Pondweed							
<i>P. Richardsonii</i>	C	C	NC	NC	NC	NC	--
Leafy Pondweed							
<i>P. foliosus</i>	C	C	C	NC	NC	NC	--
Horned Pondweed							
<i>Zarnichellia</i> spp.	C	C	NC	NC	CC	CC	--
Bushy Pondweed							
<i>Najas flexilis</i>	NC	NC	C	NC	CC	C	--
Southern Naiad							
<i>Najas guadalupensis</i>	NC	NC	C	NC	CC	C	--
Burreed							
<i>Sparganium</i> spp.	C	C	NC	NC	NC	NC	--
Waterstar Grass							
<i>Heteranthera</i> spp.	C	C	C	NC	CC	CC	--
Coontail							
<i>Ceratophyllum</i> spp.	C	C	C	C	C	C	--
Water Milfoil							
<i>Myriophyllum</i> spp.	NC	C	C	C	C	C	--
Bladderwort							
<i>Utricularia</i> spp.	NC	CC	C	NC	CC	C	--
Fanwort							
<i>Cabomba</i> spp.	NC	C	NC	NC	C	C	--
Water Cress							
<i>Rorippa</i> spp.	NC	CC	NC	C	CC	C	--
Smartweed							
<i>Polygonum</i> spp.	NC	CC	NC	C	CC	C	--
Water Buttercup							
<i>Ranunculus</i> spp.	NC	NC	C	NC	NC	NC	--
Canada Waterweed							
<i>Elodea</i> spp.	NC	CC	C	NC	CC	C	--
Widgeon Grass							
<i>Ruppia</i> spp.	NC	CC	C	NC	CC	C	--
Duckweed							
<i>Lemna</i> spp.	NC	NC	C	NC	NC	NC	--
Watermeal							
<i>Wolffia</i> spp.	NC	NC	C	NC	NC	NC	--
Watershield							
<i>Brasenia</i> spp.	NC	NC	NC	C	C	C	--
Spatlerdock							
<i>Nuphar</i> spp.	NC	NC	NC	C	CC	C	--
Sweetflag							
<i>Acorus</i> spp.	NC	NC	NC	C	C	C	--
Eel Grass							
<i>Vallisneria</i> spp.	NC	NC	NC	NC	CC	CC	CC
Arrowhead							
<i>Sagittaria</i> spp.	NC	CC	NC	C	C	C	--
Spikerush							
<i>Eleocharis</i> spp.	NC	CC	NC	NC	C	C	--
Lotus							
<i>Nelumbo</i> spp.	NC	C	NC	CC	C	C	--
Water Lily							
<i>Nymphaea</i> spp.	NC	C	NC	CC	C	C	--
Cattails							
<i>Typha</i> spp.	NC	NC	C	CC	C	C	--
Bulrush							
<i>Scirpus</i> spp.	NC	NC	NC	C	CC	C	--
Wildrice							
<i>Zizania</i> spp.	NC	NC	NC	NC	NC	CC	--
Water Willow							
<i>Dianthera</i> spp.	NC	NC	NC	CC	CC	C	--

C = Controlled by Herbicide.

CC = Conditionally Controlled by Herbicide

NC = Not Controlled by Herbicide.



Aquatic Plant Nuisance Before and Five Days after Chemical Control on Rice Lake, Barron County (Courtesy of The Lake Biologist, Inc.)

Comparison of Methods

Mechanical control techniques with current equipment available are most readily utilized in combination with chemical control methods. Cutting equipment efficiency is greatest in deep waters. Since chemical control costs increase with increasing depth chemicals are used in shallow water and adjacent to piers where the efficiency of mechanical equipment is reduced.

Mechanical control methods have specific advantages over chemical control methods in that there is no chance of a chemical residue and since the weeds are actually removed, the nutrients that would be recycled if the weeds were killed are also removed. Even though the potential of nutrient reductions through weed removal is small, it is one of the few methods available that provides any nutrient removal.

Some of the disadvantages of mechanical weed removal over chemical weed control include:

1. A relatively high initial investment in commercial-size equipment.
2. A seasonal operation with extensive maintenance and support demands.
3. Developing suitable disposal sites for the weeds.
4. Relatively rapid regrowth of the cut weeds, particularly in shallow water.
5. Operationally inefficient in shallow water and around piers where most effective weed control is desired.

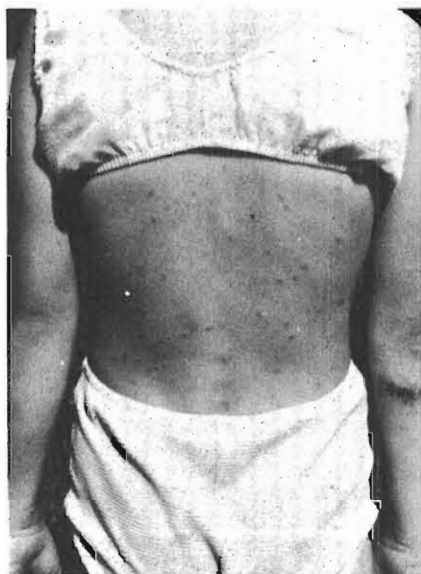
SWIMMERS' ITCH

One of the best known of the Egyptian papyri, "Papyrus Ebers" which dates back to 1550 B.C. deals with a disease referred to as the AAA disease. The symptoms described and the hieroglyph used lead modern medical interpreters to believe that this ancient disease was the same as what we know today as bilharziasis or schistosomiasis. The principal symptoms are blood in the urine caused by a parasitic flatworm (*Schistosoma*) in the urinary bladder or ureter. The causative organisms are host specific, and the most serious disease-producing species occur in tropical and subtropical regions of the earth. In Wisconsin, however, there are species present that attack various animals and often accidentally attack swimmers, causing an uncomfortable dermatitis.

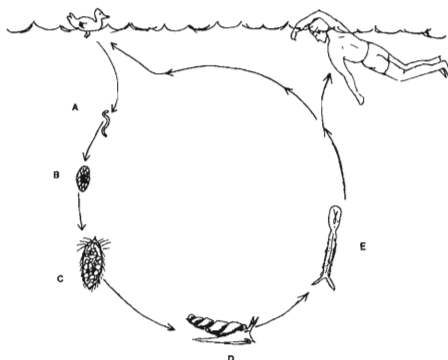
DEVELOPMENT OF THE ORGANISM

The adult worm lives as a parasite in the tissue of a suitable mammal or bird, and produces eggs which pass with the droppings of the host animal into the water. Upon hatching, the embryo develops into a ciliated organism called a miracidium which swims about in search of a second host animal, a particular type of snail. If the snail is located within a few hours, the miracidium will penetrate into the soft tissues and pass through a second reproductive phase. The organism that is released from the snail is called a "cercaria" and is an active swimming stage again seeking the primary host animal or bird.

During the active swimming state, the life cycle may be interrupted when the cercaria accidentally penetrates the outer layer of skin of bathers. The cercariae are soon destroyed by natural body defense mechanisms, but the site of penetration is apparent by a small red welt, discomfort and itching. The degree of discomfort and bodily reaction resulting from penetration varies with the sensitivity of the individual and the degree of infestation. In some persons, the reaction may be hardly noticeable. Other persons have considerable pain, fever, severe itching



Typical swimmers' itch injury. Note the random scatter of the attack points. (The skinned elbow is not related to cercariae attack). Courtesy of The Lake Biologist, Inc.



Life cycle of swimmers' itch cercariae: (A) blood fluke carried by water bird; (B) egg; (C) miracidia; (D) snail host; (E) cercariae seeking host.

and swelling. The swelling will usually subside within a week but the red coloration can persist for some time longer. The skin irritation is not contagious.

Many of Wisconsin's finest recreational beaches are plagued by this flatworm pest every year. Other lakes have the nuisance in a particular year with no recurrence. The absence of an infected host bird or animal population or of a suitable species of snail to provide the alternate host may contribute to the sporadic distribution of

the nuisance organisms.

The swimmers' itch organisms are most commonly noted in early summer, about the time summer water temperatures reach a seasonal maximum. In the southeast Wisconsin lake region, the incidence of swimmers' itch is most prominent in late June and early July. The season is usually relatively short since water temperatures approach the high eighties and the cercariae are released from the snails during a period of relatively few days. In the northern portion of the state, the water temperatures are slightly lower so the swimmers' itch season is delayed to perhaps early or mid-July. Since the cercariae are not released from the snails as readily at the low temperatures, the infective season, rather than lasting a few days, may last throughout the remainder of the swimming season.

After the cercariae have penetrated the skin, there is little that can be done in the way of treatment. Some relief from the itching may be obtained through the use of a soothing lotion such as calamine or lotions that have additives such as antihistamines and/or local anesthetics.

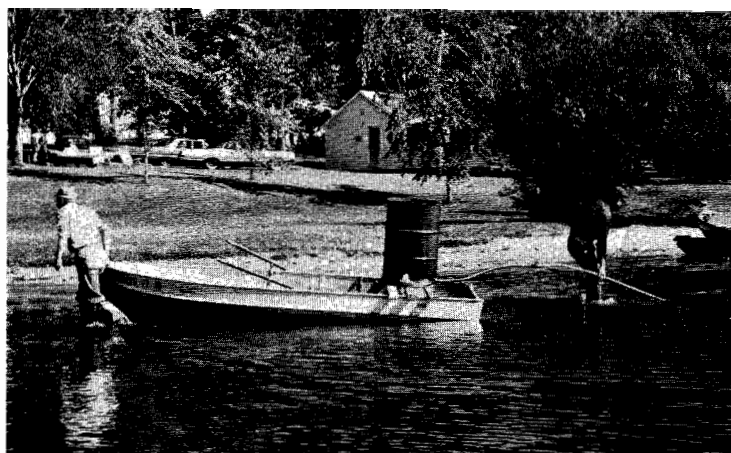
In past years, there have been lotions marketed as preventatives against cercariae penetration but the effectiveness of these products leave much to be desired. Some simple preventive measures are possible, however. The cercariae are delicate little animals which when deprived of water will dry up and die. Furthermore, there is some evidence that actual penetration takes place after emerging from the water. Consequently, a brisk rubdown with a towel immediately after emerging from the water will minimize the number of successful penetrations. This procedure, of course, is impractical for small children that dabble at the shoreline or for bathers that are continuously in and out of the water.

CHEMICAL CONTROL

Procedure

With our basic knowledge of the relationship between *Schistosoma* cercariae and snails, it has been possible to devise control procedures that eliminate both the host snails and the cercariae. Since the host snail and the free swimming cercariae move only short distances, the control procedure can be confined to the immediate area of the beach and there is no need to destroy extensive snail populations.

Simplified equipment for applying chemicals for swimmers' itch control mounted and operational in an aluminum fishing boat. This equipment can be modified for extensive projects by using a 3 horsepower centrifugal pump to keep the chemical mixed and pump the material through the distribution system.



Several chemicals have been utilized, but copper sulphate has been by far the most widely used for snail control. The chemical is usually used at a rate of 80 pounds copper sulphate per surface acre of the beach. Since both snails and cercariae have some mobility, treatment areas encompass at least one acre and include 50-100 feet of shoreline on both sides of the beach. To avoid undue toxicity to fish at this high rate, the copper sulphate is usually mixed with $\frac{1}{2}$ as much lime to effectively precipitate the chemical and force it to settle onto the bottom muds where the snails are thoroughly exposed. The fish in the upper water layers are, therefore, not affected.

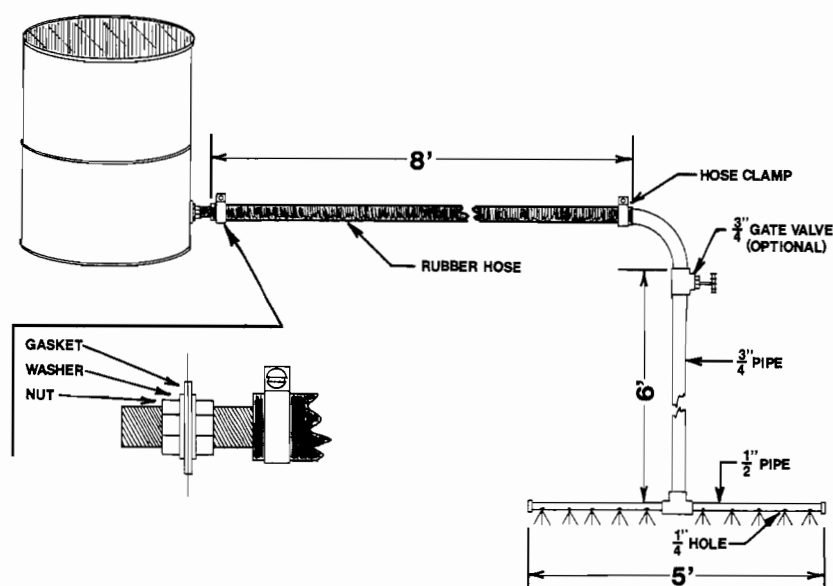
The application of the chemical is most readily accomplished by draining the slurry of copper sulphate, lime and water from a barrel through a hose or "T" bar onto the bottom (Fig. 2). The chemical is not harmful to bathers but better results are obtained if swimmers are excluded from the beach for a few hours to permit the chemical to settle. Applications are not made when rough water is present, since this would tend to disperse the chemical more widely.

This treatment is a relatively violent ecological manipulation and for that reason, is usually confined to relatively small areas of a lake. However, even where extensive shoreline areas are treated annually, there is no apparent

ecological damage to the lake. The very nature of applying the chemical as a settleable solid provides that the chemical is quickly incorporated into bottom muds and effectively lost to the lake as an active toxicant.

This type of chemical control is practiced on many Wisconsin lakes annually as a preventative and/or solution to the swimmers' itch nuisance. In general, it is successful. However, even after a beach has been treated, there may be incidences of swimmers' itch. This will most usually be associated with a relatively strong onshore wind where water currents transport cercariae from untreated areas to the swimming beach.

FIGURE 2. Simplified Equipment for Applying Chemicals for Swimmers' Itch Control



Use on Wisconsin Lakes

A total of 48 lakes have received some type of swimmers' itch control (Table 6, App.). Most lakes that are plagued with the problem are treated on an annual basis. Typically the treatment is confined to a relatively small swimming beach but in at least two cases, Lake Metonga in Forest County, and Lake Noquebay in Mari-

nette County, the control program is applied to extensive shoreline areas. The treatment is usually in mid-June in the southern part of the state, and in early July in the north.

The incidence of swimmers' itch is more noticeable in the northern part of the state. This is perhaps due to the fact that water temperatures do not reach the same levels as in the south and consequently, the release of cer-

cariae by snails is extended over a greater period of time with a higher probability of affecting bathers. Treated beaches can usually be cleared of infected snails but when bathing on days when the wind is onshore, the water currents bring different cercariae onto the beach. Beaches must, therefore, be carefully selected during the swimmers' itch season to avoid the infection even on treated beaches.

DEVELOPMENT OF CONTROL PROGRAM

Every year, complaints about aquatic nuisances and requests for assistance in controlling them are investigated by the Department of Natural Resources. The conditions observed are not unique. Man has been plagued with nuisance aquatic growths in surface waters for a long time as may be attested by publications regarding the problem which appeared in the mid-19th century.

Investigators active in the early 1900's promoted the use of copper sulphate for the control of planktonic algae in water reservoirs. Copper sulphate came into more or less general use as a reservoir algicide. In 1918, the City of Madison began using it on recreational waters. In 1925, the systematic treatment of an entire 3,000-acre lake was accomplished with copper sulphate. In the mid-1920's, the effectiveness of arsenic trioxide on terrestrial plants was expanded successfully to the aquatic community, and in 1926, the City of Madison first used sodium arsenite in the control of an aquatic nuisance for the enhancement of recreational values of an area. By the early 1930's, several published reports had substantiated the effectiveness of arsenic trioxide for aquatic plant control on recreational waters with a relatively substantial margin of safety for fish and fish-food organisms. By the mid-1930's, chemical aquatic nuisance control activities centering around copper sulphate and sodium arsenite had expanded to many Wisconsin recreational waters and in 1938, there developed a controversy between sportsmen's groups and property owners on a particular Wisconsin lake. Following this controversy, an executive order established a com-

mittee to review the problem of algae and aquatic plant control in public waters. This Interdepartmental Committee continued in existence as a Subcommittee of the Committee on Water Pollution. Late in 1966, the newly created Department of Resource Development Board reestablished this Interdepartmental Committee as an Advisory Committee to the Director of the Department of Resource Development.

The Interdisciplinary Advisory Committee concept of regulating chemical control of aquatic nuisances was also adopted when the activity was incorporated into the operation of the Department of Natural Resources in 1968. The principal functions of the original committee were three-fold:

1. To supervise aquatic nuisance control activities on Wisconsin public waters.
2. To investigate the technical aspects of chemical applications to Wisconsin public waters when applied for purposes of aquatic nuisance control.
3. To perform educational services to sponsoring organizations and insure proper planning of aquatic nuisance control activities so as to obtain the most possible benefit without damage to desirable aspects of the environment.

The functions of the current Advisory Committee are essentially the same. Shortly after the executive committee was appointed in 1938, to assist in resolving technical and public relation difficulties concerned with chemical aquatic nuisance control, a permit system was implemented and has continued to the present.

In 1941, the Wisconsin Legislature

passed an act calling upon the Committee on Water Pollution "...To supervise chemical treatment of waters for the suppression of algae, aquatic weeds, swimmers' itch and other nuisance producing plants and organisms. It may purchase equipment and may make a charge for the use of the same and for materials furnished together with a per diem charge for services performed in such work. The charge shall be sufficient to reimburse the Committee for the use of equipment, the actual cost of materials furnished and the actual cost of services rendered, plus ten percent for overhead and development work." This legislation was basically carried into Chapter 614, Laws of 1965, under Section 144.025.

During the 1940's, the Committee purchased and operated chemical spraying equipment which was made available to sponsoring organizations on a rental basis. As the program expanded, the demand for state-owned equipment became impractical and in 1949, the use of state-owned equipment was discontinued. By 1950, comprehensive records were maintained concerning important phases of chemical control activities.

Since the inception of the program, the principal chemicals used have been copper sulphate for algae control and arsenic trioxide for weed control. During the last ten years, new organic herbicides have been brought on the market to replace sodium arsenite as an aquatic herbicide. Before a product can be used on Wisconsin waters, it must be registered by the U.S. Environmental Protection Agency, the Wisconsin Department of Agriculture, and must further be approved by the

Advisory Committee on Aquatic Nuisance Control. The use of chemicals in the control of aquatic nuisance growths on Wisconsin recreational waters since records were begun in 1950 is summarized in Table 7 (App.).

The use of chemicals on lakes is very carefully regulated to prevent undue ecological damage and the Wisconsin Department of Natural Re-

sources is charged with this responsibility. Sponsoring organizations such as resort owners, municipalities or private individuals must first obtain a permit from the Department of Natural Resources before application of chemical can proceed. Application blanks for a permit may be obtained by writing to the Department of Natural Resources, Box 450, Madison,

Wisconsin 53701. Once a permit has been issued, a representative of the Department (if required by the permit) will be present at the time chemicals are actually applied to insure that dosage computations are accurate and the chemicals are not misused. The sponsoring organization is required to pay a nominal fee for this supervisory service.

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TABLE 2. Lakes Treated with Copper Sulphate for Algae Control.

Lake	County	Pounds of Copper Sulphate																			Total		
		1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969		
Agasson	Oconto																		20		20		
Altoona	Eau Claire												800	1,490 ²	1,400	1,000	800	1,100				6,590	
Barney	Dane																225					225	
Bass	Oneida		25			25																95	
Bear Trap	Polk								700	1,200 ²	1,700 ²	1,700 ³	1,600 ³	2,100 ⁵	2,100 ⁵	1,800 ⁵	2,000 ⁴	2,500 ⁴	1,200 ⁵			18,600	
Beaver Dam	Barron										2,500 ²						2,350 ³	1,700	700	900	1,350 ³	9,500	
Boulah	Walworth	50												500								550	
Big Butternut	Polk								3,800 ²	1,700		1,500	1,000	1,700 ²	2,200 ²	850	500	800 ²				14,050	
Big Cedar	Washington										1,800 ²	3,800 ⁴	2,900 ⁴	3,550 ⁵	3,540 ⁵	3,750 ⁷	1,800 ³	300				21,440	
Big Silver	Waushara											50										50	
Bing	Waushara				66																	66	
Blue Spring	Jefferson					250																250	
Boot	Iron			970 ²																		970	
Brown's	Racine	100						150				575	400									1,225	
Bugh	Waushara																					62	
Cable	Bayfield																10					10	
Camp	Marinette														70	70	70					210	
Camp McCoy Ponds	Monroe																				13*	13	
Cedar	Polk	800		1,600 ²	1,600 ²	800	800	800	18,775 ⁴	10,800 ³	2,400	15,200 ²	9,200 ⁴	11,800 ¹¹	9,800 ⁸	10,800 ¹⁰	10,300 ⁹	13,500 ¹³	8,700 ¹⁰	7,600 ¹⁰	10,150 ⁹	139,025	
Chetek Chain	Barron																					1,755	
Clear	Polk							225	225	525 ²			300				50					4,590	
Coleman	Marinette																	1,300 ²	900	800		2,000	
Crane	Forest																			200	200 ²	400	
Crystal	Sheboygan	175	700 ²	400	400	400		400	400	400	400	400	400	400	400	400	400	400	400	300 ²	390 ²	7,565	
Dallas	Polk																	85				135	
Deer	Polk	350																				930	
DeLavan	Walworth	1,710	2,500	1,800	2,050	1,000	1,100	700	480	5,200 ⁹	3,000 ⁵	7,600 ¹³	6,900 ¹³	8,200 ¹⁴	7,900 ¹⁴	7,550 ¹³	6,400 ¹³	4,200 ¹¹	4,625 ¹³	6,005 ¹⁴	2,193 ⁶	81,113	
Delton	Sauk																					3,295	
Eagle	Racine								1,800		1,200	2,000 ²	4,500 ⁷	3,300 ⁶	700 ²	400	400	950 ²	800 ²	1,000 ²	1,600 ⁷	18,650	
Eagle Spring	Waukesha		20		30																	250	
Eau Claire	Eau Claire																900	800 ²				1,700	
Elk Creek	Dunn									300		300						300	400 ²		200	1,650	
Emery	Marquette														100	150						250	
Engish	Manitowoc																				200 ²	200	
Fin "N" Feather	Jefferson																			40	49.5 ²	89.5	
Fish	Waushara														150 ³	540						125 ²	815
Five	Washington	600		600	500		500						500			400	200					350 ²	3,650
Flora Dell	Monroe																					50 ²	75
Fowler & Oconomowoc R.	Waukesha																	25				225 ²	2,506
Geneva	Walworth	1,050	1,365	1,280	660	1,410	770	1,000	1,800	1,450	1,800	1,550	1,400				1,720 ⁴	400				60	18,915
George	Kenosha																						160
Gilbert	Waushara										15								10	10		140 ³	15
Goose	Adams													350									700
Green Bay	Door											200									230		200
Hall Moon	Eau Claire		480	480	2,090	5,200	4,000	3,700	7,200	6,500 ⁸	3,400 ⁵	5,600 ⁷	8,000 ¹¹	8,000 ¹⁰	4,800 ¹¹	12,100 ¹⁸	4,505 ¹⁰	4,600 ¹¹	4,800 ¹²	4,600 ¹¹	3,080 ¹⁰	93,135	
Hills	Waushara																					15	
Horseshoe	Manitowoc																					1,160	
Iola	Waupaca																400 ³	100	200 ²	110 ²	350 ⁴	225	
Keating	Waupaca																					135	
Keessus	Waukesha												100	35									135
Kegonsa	Dane	55,420	48,928	46,515	41,189	25,102										1,600 ³	1,710 ²	2,420 ³	1,500 ³	700 ²	495 ³	10,410	
Kettle Moraine	Fond du Lac																					217,154	
La Belle	Waukesha									200		475	700	400	175		500 ²				45	1,715	
Lauderdale Chain	Walworth																					900	
Lazy	Columbia																	33	85		27	145	
Lincoln Park	Kenosha																					475	
Lion's Beach	Rock	75	75	75	75	75	75				75	75	75	75	75	75	75	75	75	75	20	60	
Little Cedar	Washington																					1,175	
Little Long	Manitowoc																	700				700	
Little Muskego	Waukesha									200 ²												100	
Little St. Germain	Vilas																					200	
Long	Fond du Lac										4,200	5,000 ²	2,900	3,800 ⁴		7,200 ⁴		1,600		2,300 ²	1,400	28,400	
Long	Manitowoc																					100	
Long	Polk												700		930	800 ²	750 ³	1,100 ³	1,600 ⁴	800 ²	800 ³	5,850	
Lorraine	Walworth						300	300														5,730	
Lower Phantom	Waukesha											100	100									600	
Marion Mill Pond	Waupaca																					45	
Mendota	Dane	176	738		127																	245	
Menominee	Dunn																					50	
Menominee Park Pond	Waukesha														4,600 ⁴	9,000 ⁹	8,800 ¹⁰	6,900 ⁸	7,500 ⁸	3,900 ⁵		40,700	
Mercer	Oneida																					50	
Mid	Oneida						1,200	1,200	1,200	1,200	1,200	1,050	1,100 ²						400 ²	600		1,000	
Mirror & Delton	Sauk	700	700		900	1,400	1,300	1,300	1,400	2,800 ²	1,200	1,100	3,000 ²	55	600	600	1,800 ⁴	650 ²				6,950	
Mirror	Waupaca																					19,505	
Monona	Dane	20,823	12,245	6,341	4,894		918	2,194			375											50	
Mt. Hope Pond	Grant																			249.5 ⁴	60	48,099.5	
Mukwonago Park	Waukesha																					22	
Mullet River	Sheboygan																					31	
Muskego Park	Waukesha															700 ²						15	
Nagawicka	Waukesha	20	15								200	250	300	400	1,400	2,200 ³	1,400 ²	1,440 ²	1,150 ³			895	
Nehmabin	Waukesha																					50	
Nepoo	Wood	4,000	5,500	2,800	5,200	8,850	4,750	9,500	9,000	5,900 ²	8,050 ³	5,300 ²	5,100 ²	4,600 ²	3,900 ³	4,350 ⁴	2,350 ³	4,100 ⁴	4,400 ⁴	3,900 ⁴	2,200 ²	9,180	
North	Waukesha			300																		300	
Oconomowoc	Waukesha							50		200	100											1,607	
Okauchee	Waukesha																						

TABLE 2 (Cont.)

Lake	County	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	Total
Paquette Park	Columbia																			13	12 ²	25
Park	Columbia																	1,250	1,030 ³	1,430 ⁴		3,700
Perch	Monroe													175	160	110 ²	176	180	200	225 ²		1,226
Peter's	Walworth																			350 ³	480 ⁵	1,080
Pewaukee	Waukesha	11,300	4,200	5,000	7,000	8,700	13,000	10,950	5,955	9,105 ¹⁰	7,575 ⁸	6,600 ⁷	6,750 ⁷	7,600 ⁸	6,215 ⁷	5,440 ¹⁴	6,150 ¹⁴	2,464 ⁷	250	1,250 ⁵	200	125,454
Pickereel	Portage									600 ³	600 ³	100	250	110	150		200		250	150 ²	200 ²	2,610
Pike	Marathon	1,000	850	1,000											850	1,600 ²	800	800	1,900 ³	250	1,125 ²	10,175
Pine	Waukesha	450	800	800	1,500	1,200	400	2,180	2,050	450	800 ²	995 ³	1,175 ³	802 ³	850 ²	570 ²	330 ²	1,057 ³	1,025 ³			17,434
Pokegama	Washburn													500 ³								500
Potter's	Walworth												400	1,200 ²	1,130 ²		750			550	650 ²	4,680
Pretty	Waukegan																	100			100	200
Redstone	Sauk																			2,300 ⁶		2,300
Ragner	Washington																				12	12
Rib	Taylor								425													425
Round	Burnett												1,000	1,000 ²	600				1,000 ³	825 ³		4,425
Sand	Polk																	80 ³	140 ²	120 ³	40	380
Sandow	Marquette																		50		30	100
School Section	Waukesha							300													72	372
Shangrila	Kenosha											350	800		275	550	600	400			35	3,010
Silver	Columbia																		90	85		175
Silver	Waupaca																		400 ²			400
Springbank	Monroe											40	35	35					109 ³	98 ⁷	45 ³	362
Squaw	St. Croix																				400	400
Swan	Columbia																				5	5
Token Creek Pond	Dane																				19.5	19.5
Tomah	Monroe													1,100 ¹		500		700	575 ²	805 ²	1,250 ²	4,930
Trade	Burnett																			550	550	550
Trempealeau River	Trempealeau																			25	25	50
Troy Mill Pond	Walworth																	25				25
Upper Nehmabin	Waukesha											200 ²								42 ²	50	292
Wapogasset	Polk	2,740	4,360	5,400	2,800		5,600	2,700		2,300	4,050 ²	4,400 ²	7,200 ³	5,265 ⁵	11,100 ⁵	10,200 ⁵	9,750 ⁵	7,800	10,550 ⁴	3,000 ⁵	3,525 ⁸	102,740
Waubesa	Dane	52,965	53,050	49,103	54,359	46,697																256,174
Wausau	Marathon														410 ²							410
White Ash	Polk																				200	200
Whitewater	Walworth						2,000				2,000		900	600	1,200 ²	1,200 ²	1,000 ²	1,200	1,700 ³	1,800 ²	1,370 ²	14,979
Whitnall Park	Milwaukee																	26				26
Wilkie	Manitowoc												300									300
Wind	Racine									100												100
Windfall	Forest																				4.5	4.5
Wingra	Dane								50													50
Winnebago	Winnebago	69	70	75	100																60	374
Wisconsin	Columbia				40						5,150	700	1,900	1,550 ²	200	1,300			50			10,890
Zoo Ponds	Racine																				8	8
TOTAL		154,573	136,621	124,539	125,580	101,109	36,713	37,949	51,060	55,486	54,215	65,885	81,565	78,407	78,045	110,861	72,774	69,880	61,519	44,710	43,603	1,585,094

* 1.5 gallons of Hydrothall 47

** Plus Cuprose - 125 lb.

Exponents refer to the total number of treatments in any one year.

TABLE 4. Control of Aquatic Plants with Sodium Arsenite, 1950-1969.

Lake	County	Pounds Arsenic Trioxide																				TOTAL
		1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	
Alexander	Lincoln													2,700								2,700
Angelo Pond	Monroe																	720	2,880	1,980		5,580
Antigo Ponds	Langlade													2,160	540	180	2,160	2,160				7,200
Ashippun	Waukesha				400																	400
Bass	Oneida		750			750		720			780		720		900		900		900	900		7,820
Bear Trap	Polk										32											32
Beaver Dam	Barron										1,080						1,980	1,890				4,950
Beck	Washington	200																				200
Beulah	Walworth	200					140			8,460				15,216	6,732							30,748
Big	Polk									752(2)												752
Big Cedar	Washington	60					1,120	3,480	14,940	34,920	23,040	3,240	10,740	12,636	28,446	13,854	15,840	11,718	3,750	540	840	179,164
Big Rock-a-Cri	Adams										3,720	5,220		4,500	1,620	1,800		2,700				19,560
Big Silver	Waukesha										3,420	3,960	1,980			3,780	1,980					15,840
Bing	Waushara				1,072	5,540																1,072
Blue Spring	Jefferson			5,620	5,200																	16,360
Bohner's	Racine		376							360			1,260	1,260								3,256
Brown's	Racine	540					1,600	4,360	480	9,660		19,800	20,160									56,600
Cahokia	Waushara			660																		660
Camp	Marinette														1,800							1,800
Campbell's Pond	Oconto								220	340												560
Cary Mill Pond	Waupaca								720	1,272												1,992
Cedar	Manitowoc						300	300	420													1,020
Cedar	Polk								280													280
Center	Kenosha										20											20
Chetek Chain	Barron								5,988	3,964	3,048	9,800			540	1,320						24,660
Chilton Pond	Calumet								1,540	1,060	1,540				1,620	1,620	1,620	1,620	1,620			12,240
Clintonville Pond	Waupaca								2,640	1,760												4,400
Cox Hollow	Iowa													180								180
Crooked	Oconto					620		1,400								2,160						4,180
Crystal	Sheboygan																		360			360
Decorah	Juneau														360			181				541
Deer	Polk						350		332	360						1,260						2,302
Delavan	Walworth	1,400	1,800	1,600	1,696	1,500	1,080	840	480													10,396
Delton	Sauk														900(2)							900
Denoon	Waukesha	304	304	304	304		468	516														2,200
Dyer	Kenosha														450							450
Eagle	Racine										4,680	2,700										7,380
Eagle Spring	Waukesha		400	600	600			600					720	720	720							4,360
Easton Pond	Adams									1,180	1,800											2,980
Elhne's	Washington		1,600																			1,600
Elizabeth	Kenosha																		360			360
Elk Creek	Dunn										288											288
Elkhart	Sheboygan																360	90				450
Emery	Marquette														1,620							1,620
Fay	Florence														360							360
Fin "N" Feather	Jefferson																		990			990
Flora Dell	Monroe																	900		540		1,440
Forest	Fond du Lac			2,460	2,600																	5,060
Fowler & Oconomowoc R. 78	Waukesha	532	2,400	2,800	3,200	6,840	8,384	10,740	12,060	11,160	8,820	5,580	7,200		7,740							87,456
Fox R. (Buena)	Racine					2,160				1,908	1,980	2,540	2,540	2,520	3,240							16,888
Fox	Dodge			10,620																		10,620
Fox R. & Tichigan	Racine														5,340							13,170
Friendship	Adams											7,160	3,240				3,600	4,230				10,400
Geneva	Walworth	1,200	2,600	1,188	1,004	720	960	2,360	2,084	1,920	1,920	2,160		3,060	3,240		3,240		1,440			29,096
George	Kenosha										780	1,880	1,800					60	120			4,640
Gilbert	Waushara									72												72
Goose	Adams											1,760		900								2,660
Green	Green Lake	320		168																		488
Green	Walworth										900				360							1,260
Half Moon	Eau Claire				3,400	1,560	5,240		1,120	4,028			680									16,028
Hartford Mill	Washington	1,000	1,200	1,200	1,200	1,200	1,440		1,596	1,400												10,236
Hartlaub's	Manitowoc									220						360						580
Hill's	Waushara	32	32	32	40	32	40	48	36		60	32	48	48	90	60		60	90			780
Katrine	Dane											280										280
Keating	Waupaca												360	180								540
Kee Non Go-Mong	Racine					900																900
Keesus	Waukesha			4,684	1,900																	6,584
Kettle Moraine	Fond du Lac											1,100	1,100			1,100						3,300
Kiel Pond	Manitowoc										780											780
Knight's Pond	Waukesha							220	440		392	360	268	360		360						1,548
La Belle	Waukesha				400	1,508	2,520	8,640	16,536	10,220	7,740	4,860	12,240	3,366	4,800	1,260	1,260	1,248	1,260			77,858
La Crosse Park	La Crosse										280											280
Lauderdale	Walworth		468					480	928	600				800	1,710	1,350	2,610(3)	3,150(7)	3,070(4)	2,340(3)	540	18,046
Lincoln Park	Kenosha	600	600	600	600									660	630	540	540	540	540	540		6,390

TABLE 4 (Cont.)

[illegible]

TABLE 4 (Cont.)

Lake	County	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	TOTAL
Twin	Waushara																	90				90
Upper Nemahbin	Waukesha										900											900
Virginia	Waushara															180	120					300
Voltz	Kenosha																360					2,320
Wandewega	Walworth	1,920							3,828						160	120		720	1,240			6,148
Wapogasset	Polk				128	160					800						120					1,088
Waterville	Waukesha													540								540
White River	Waushara									440						180	540					1,160
Whitewater	Walworth	5,600	4,800		2,800					4,860	6,300	5,040	6,480	4,740	5,580	4,860	4,860					55,920
Wilkie	Manitowoc									1,760	2,200		2,200									6,160
Willow Springs	Waukesha															900						900
Willow Mill	Columbia																	1,260				1,260
Wind	Racine																					880
Wingra	Dane								980	880		700	1,000									4,240
Winnebago	Winnebago	200		296	300	400				720	840		360	180	582	540						2,858
Winneconne	Winnebago															1,290						1,290
Wisconsin	Columbia			500	800							220		180								1,700
Yellow	Burnett									3,420	1,980	840	868									7,108
Zanders	Green							440														440
		54,012	62,750	71,184	57,140	88,338	75,882	95,324	142,452	222,680	185,988	171,204	165,724	116,424	183,106	128,410	101,767	90,497	97,972	46,440	840	

20-Year Total (167 Lakes) 2,158,354

TABLE 5. Control of Aquatic Plants with Organic Herbicides, 1958-1969.

Pounds Active Material															
Lake	County	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	Chemical	
Alexander	Lincoln						90	114						Endothall	
Amacoy	Rusk												2	2,4-D	
Angelo Pond	Monroe										72			Diquat	
Antigo Ponds	Langlade							3.6					7.2	Endothall	
													10	Silvex	
Apple River	Polk										2.7	2.9	140	Diquat	
Arkdale	Adams										3.75	4.0	4.3	Endothall	
Balsam	Polk			145	60								6.0	Silvex	
													80	Diquat	
														2,4-D	
									8.1	8.1	73.9 ⁽²⁾	16.2	40	Diquat	
Baptist Camp Pd.	Marquette								11.25	11.25	17.5	22.5	165	Endothall	
Barnes	Bayfield									21.6				Silvex	
Bass	Oneida						90							Endothall	
													8	2,4-D	
														Diquat	
Bear	Oneida												25.2	Endothall	
													8	Silvex	
Beaver	Waukesha	166			120								1.5	Endothall	
Beaver Dam	Barron												2.0	Silvex	
														2,4-D	
											34		34	Endothall	
											48		48	Silvex	
											80		20	2,4-D	
													12	Silvex	
Beulah	Walworth				32								12	4	
														Diquat	
									40					Silvex	
Big Butternut	Polk													2,4-D	
												10.4	10.8	Endothall	
Big Cedar	Washington				108.6							14.4	15.0	Silvex	
Big Roche-a-Cri	Adams								7.2	25.4				2,4-D	
										35				Endothall	
Big Round	Polk													Silvex	
													27	Endothall	
													37.5	Silvex	
Big Silver	Waushara								16.2					Endothall	
Birch	Oneida								22.5					Silvex	
													3.6	Endothall	
Blacksmith	Menomonee												5.0	Silvex	
Blake	Polk												52	Silvex	
Blue	Oneida											3.6	2.2	Endothall	
											1.8	3.6	3.6	Endothall	
Bohners	Racine										2.5		5.0	Silvex	
													12	Diquat	
Bond	Douglas									1.8			4	Silvex	
										2.5				Endothall	
Bone	Polk													Silvex	
												10		2,4-D	
										8.5				Endothall	
										12				Silvex	
													4	Diquat	
Bong Ponds	Kenosha							36						Endothall	
Boom	Oneida										3.6			Endothall	
Brock Pond												28.8		Endothall	
												40		Silvex	
Bunny	Walworth											1.8		Endothall	
												2.5		Silvex	
Cable	Bayfield								10.5					Endothall	
Camp	Marinette								4					Diquat	
Camp McCoy Pds.	Monroe												105.4	Endothall	
													148.8	Silvex	
Catfish	Vilas					20	17	10	17	12	20	10	10	2,4-D	
Chetek Chain	Barron										1.8	32.4	9	Endothall	
											2.5			Silvex	
													28	Diquat	
Chute Pond	Oconto												2	2,4-D	
Clam	Burnett												252	Diquat	
													15	Endothall	
													8	Silvex	
Clear	Lincoln											1.5		Endothall	
Clear	Polk								90		27		18	Endothall	
											37.5			Silvex	
													28	Diquat	
Clear	Rock							18	106.2		38.7			Endothall	
									53.75					Silvex	
Content	Vilas												1.3	Endothall	
													2.5	Silvex	
Cox Hollow	Iowa					30	70	20	91			150	140	2,4-D	
Crane	Forest												12	Diquat	
													8	Endothall	
Crawling Stone	Vilas													3.6	Endothall
Crooked	Sheboygan													1.8	Endothall
													2.5	Silvex	
Crystal	Columbia & Dane									0.9				Endothall	
										1.25				Silvex	
										6	110			Diquat	
Crystal	Sheboygan											21.6	74.4	Endothall	
													7.0	Silvex	
													20	Diquat	

TABLE 5 (Cont.)

Lake	County	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	Chemical
Dallas Pond	Barron								110.7	22.5	43.2		280	2,4-D
									40.9	31.2	60			Endothall
Dana Farm Pond	Kewaunee										3.4			Silvex
											4.8			Endothall
Decorah	Juneau							93.2	160					Silvex
								73						Diquat
Deer	Polk													Endothall
														76 Diquat
														81 Endothall
														3.6 Endothall
														5.0 Silvex
Delton	Sauk									85	103.8			9.9 Endothall
										120	146.5			13.7 Silvex
										80	6			Diquat
Diamond	Oneida				7									2,4-D
Eagle Springs	Waukesha													Diquat
Elizabeth	Kenosha									43.2	19.8		3.0	Endothall
											27.5			Silvex
Elkhart	Sheboygan													60 Diquat
Emery	Marquette									32.4	41.4			Endothall
Fairwood	M									45	57.5			Silvex
Fairwood	Marquette													54 Endothall
Fay	Florence													48 Diquat
Fin 'N' Feather	Jefferson											1.7		8
												2.4		Endothall
												8		Silvex
														2,4-D
														38.3 Dalapon
														24 Diquat
Fish	Waushara													19.8 Endothall
														27.5 Silvex
Five	Washington									173.7				Endothall
										1.25				Silvex
Flora Dell	Monroe											.85		Dowpon
												20		2,4-D
												59.5		Endothall
												90.8		Silvex
Fowler					60									24
														2,4,5,-T
														8.8 Diquat
														400 2,4-D
Fox River	Racine					8.5								Delapon
											16	24	4.5	Silvex
												17		Endothall
												40		2,4-D
														63 Diquat
Geneva	Walworth								4	12	12			76 Diquat
									21.6	43.2	155	218.4		87 Endothall
									3.7		168	308	122	Silvex
George	Kenosha									6				Endothall
										60	30			2,4-D
											20			Diquat
														16 Diquat
Gollens Minnow Pd.	Portage											0.4		Diquat
Grass Creek	Columbia													1.7 Endothall
														2.4 Silvex
														Endothall
Gunlock	Vilas											9		9
Half Moon	Eau Claire								18	.9	3.6	3.6	3.6	Endothall
									25	1.25	5.0	5.0	5.0	Silvex
				90	35									2,4-D
					42.5									Radapon
														Endothall
												3.6		Silvex
Harris	Marquette											5		
Hawyard Park Pond	Sawyer													8 Diquat
														12.75 Dalapon
Hill's	Waushara													4 Diquat
														9 Endothall
Horseshoe	Polk													4.5 Diquat
Iola Millpond	Waupaca													807 Diquat
												136		Diquat
												30		Endothall
														4 Silvex
Island	Oneida													5.4 Endothall
														7.5 Silvex
Jacqueline	Portage													100 2,4,5-T
														14.4 Endothall
														20 Silvex
Jerome	Oneida										7.2	3.6		Endothall
											10			Silvex
Johnson	Burnett													6 Diquat
Kawagasaga	Oneida					16.2								5.4 Endothall
														12.5 Silvex
Keesus	Waukesha									7.2	21.6	14.4	6.30	Endothall
												20.0		8.75 Silvex
														18 Diquat
Kegonsa	Dane													10.8 Endothall
														15.0 Silvex
Kilby														
Kull	Kenosha										3.6	1.8		Endothall
												36		14.4 Endothall
														20 Silvex
La Belle	Waukesha													82 Diquat
														180 522 2,4-D

TABLE 5 (Cont.)

Lake	County	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	Chemical
Lac Court Oreilles	Sawyer												4	Diquat
Lauderdale Chain	Walworth											24	54	Diquat
												68.6	24	Silvex
												31.4	17	Endothall
													9	Endothall
												60	20	2,4-D
													52	2,4,5-T
Lawrence	Marquette										1.8	28.8	82.8	Endothall
											2.5	40	115.0	Silvex
												36		Endothall
Lazy	Columbia										292	160		Diquat
													108.8	Endothall
													153.6	Silvex
Leftfoot	Marinette												1.4	Endothall
													2.0	Silvex
Legend	Menominee												27	Silvex
Leota	Rock											20	40	2,4-D
													17	Endothall
													24	Silvex
Lion's Beach	Rock											18		Endothall
												25		Silvex
Little Balsam	Polk												2	2,4-D
Little Blacksmith	Menominee												105	Silvex
Little Butter-nut	Polk				25									2,4-D
											2			Diquat
												3.6		Endothall
												5.0		Diquat
Little Green	Green Lake												64	Diquat
												140		2,4-D
												53		Silvex
												34		Endothall
Little Musk-ego	Waukesha		20											2,4,5-T
				.5										Silvex
				.36										Endothall
Little Norway	Dane								4.6					Endothall
Little St. Germain	Vilas					40	118			3.6				2,4-D
Little Silver	Washington									5				Endothall
													7.2	Silvex
Little Wood	Burnett												4	Endothall
													100	Diquat
Long	Columbia										100			Diquat
Long	Iron											14.4		Endothall
Long	Polk											80	64	Diquat
													9	Silvex
Long	Waushara										1.8		14.4	Endothall
											2.5			Silvex
Lost	Vilas					23.5					3.6	3.6	10.8	Endothall
											5	5		Silvex
Lower Genesee	Waukesha												0.8	2,4-D
Lower Kaube shine	Oneida					1.8								Endothall
						7.5								Silvex
Lucas	Washington							7.2	14.4	3.6				Endothall
										5				Silvex
Mallalieu	St. Croix									3.6				Endothall
										5				Silvex
Manawa	Waupaca									12				Diquat
											17.5	17		Endothall
												24		Silvex
Marinuka	Trempealeau											7.2	138.6	Endothall
													8	Diquat
												10	5	Silvex
Marsh-Miller	Chippewa										2	4		Diquat
Maud	Oneida												150	Silvex
McDill	Portage											72	100	Diquat
												3.6		Endothall
Mendota	Dane	34												2,4,5-T
			10											2,4-Dg
			250											4% Simazine
								68						Dowpon
									254.2					Endothall
											64.8		28.8	Endothall
											90		40.0	Silvex
												298.8	356.4	Endothall
Mercer	Oneida											52.2		Endothall
												72.5		Silvex
Mid	Oneida									72				Endothall
										100				Silvex
Middle Pine Pk.	Polk											256	120	Silvex
Mill Bluff Pk.	Monroe											60	60	2,4-D
Milwaukee R.	Milwaukee								28			40		Diquat
												40		2,4-D
Minocqua	Oneida							12.6	18	14.4	23.7	30.6	21.6	Endothall
											21	32.5	30.0	Silvex
Mirror	Sauk												60	Simex
												30		Diquat

TABLE 5 (Cont.)

Lake	County	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	Chemical
Monona	Dane	28												2,4,5-T 2,4-D
			280	300	240	280	18	620		122.2	151.2	320.8	284.4	Endothall
										100	210	40	395	Silvex
Montello	Marquette						20							2,4,5-T
											6	120	404	Diquat
											37.8	48.6		Endothall
											52.5	62.5		Silvex
												7.3		Endothall
Montesian	Green													Endothall
Namekagon	Bayfield							21.6	14.4	7.2				Endothall
Neenah Slough	Winnebago							34						Dowpon
								40						Silvex
								140						Diquat
Neenah	Marquette												3.6	Endothall
													5.0	Silvex
Nemahbin	Waukesha											6	4	Diquat
													15	Endothall
Nelson	Sawyer											1.6	2.0	2,4-D
Nepco	Wood											158.4	144	Endothall
												220	200	Silvex
Nocquebay	Marinette												540	2,4-D
												3.6		Endothall
												5		Silvex
North Pond	Marinette											288		Endothall
												40		Silvex
Oconomowa	Waukesha											300	1.8	Endothall
													2.5	Silvex
												100	155	2,4-D
												4	74	Diquat
Okauchee	Waukesha											6	68	Diquat
												20	195	2,4-D
													272	2,4,5-T
												36	177.6	Endothall
												29.6	5.0	Silvex
Onalaska	La Crosse							7.4				180		Diquat
											131	90		Endothall
Paddock	Kenosha												144	2,4-D
										76				Diquat
Pacquette Pk.	Columbia									12	24		16	Diquat
Park	Columbia								2		444	640	288	Diquat
Pearl	Waushara											292		Endothall
Perch	Monroe												120	Diquat
Peshtigo	Menominee												76	2,4,5-T
Peters	Walworth									32				Diquat
												24	29.6	Silvex
Pewaukee	Waukesha					77.3				.94	18.7	1193.6	440	Endothall
										1.3	26.4	1685	550	Silvex
										193				Diquat
											60	1860	360	2,4-D
Phantom (Lower)	Waukesha												128	Diquat
													40	2,4,5-T
													30	Endothall
Pickeral	Forest & Lauglade											120	52	Diquat
													39	Endothall
Pike	Marathon											48.6	51	Endothall
												67.5	72	Silvex
											8.8			2,4-D
Pine	Waukesha					30						580		2,4-D
						5.4				39.4				Endothall
												40	348	Diquat
													25.5	Endothall
													36.0	Silvex
Pokegama	Vilas										7.2			Endothall
Pokegama	Washburn					7.2		9	14.4	5.4			30	Endothall
								12.5		7.5				Silvex
													4	2,4,5-T
Post	Lauglade					3.6	3.6							Endothall
Potters	Walworth					40						340		2,4-D
				360										2,4,5-T
			12					50	96	80		80	40	Diquat
													255	Endothall
Pretty	Waukesha												1.7	Endothall
													2.5	Silvex
Pretty	Waushara											1.8		Endothall
												2.5		Silvex
Private Pond	Ozaukee											1.8		Endothall
												2.5		Silvex
Private Pond	Walworth											1.8	1.8	Endothall
												2.5	2.5	Silvex
Reyner Park Pond	Washington												20	2,4-D
													22	Diquat
Rice	Barron											30		2,4-D
Rice	Walworth											30	40	2,4-D
River Pk. Lagoon	Sheboygan												10	Diquat
Rock	Jefferson					50								2,4-D
												.9		Endothall
												1.25		Silvex
Round	Columbia											.2		Endothall
												.25		Silvex
Round	Waushara											.36		Endothall
												.48		Silvex

TABLE 5 (Cont.)

Lake	County	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	Chemical
Sand	Polk									28.8	28.8			Endothall Silvex
											40			Diquat
Sandow	Marquette										1.8	60	24	1.8 Endothall
											2.5			2.5 Silvex
School Section	Waukesha												17	Endothall
Shangri-La	Kenosha												25	Silvex
													120	Diquat
												24		Silvex
												120	150	Endothall
												738		Diquat
Shawano	Shawano												315	Endothall
													416	Diquat
											10			2,4-D
												120	1530	Endothall
											28	738	28	Diquat
											32.4		10.8	Endothall
											45	24	15	Silvex
Shishebogama	Oneida											100		Bowpon
												16	160	2,4-D
												14	8	Diquat
													30	Endothall
													3.6	Endothall
													5.0	Silvex
Silver	Columbia								.45	1.8	170			1.1 Endothall
									.62	2.5	240			1.5 Silvex
										4				Diquat
Silver	Waupaca											120		Endothall
S. Twin	Polk									1.8	1.8	7.2		Endothall
										2.5	2.5			Silvex
Spring	Menominee												80	2,4,5-T
Springbank	Monroe											1		Divron
Storrs	Rock									50				2,4-D
Swede	Polk											216		Endothall
													2	2,4-D
Thorn	Portage											3.6	3.6	Endothall
Thunder	Oneida								2.7					Endothall
									3.75					Silvex
Tichigan	Racine												8	Diquat
													22.1	Endothall
													35.2	Silvex
Tomah	Monroe										25.2	3.6		Endothall
											35.1	305		Silvex
Tomahawk	Oneida											1		Endothall
												1.5		Silvex
Tombeau	Walworth				40									2,4-Dg
Trempealeau R.	Trempealeau												16	Diquat
													10.8	Endothall
Troy Mill Pd.	Walworth											12	20	Diquat
													20	2,4-D
Twin	Waushara									3.6				Endothall
Virgin	Oneida									7.2				Endothall
										10				Silvex
Voltz	Kenosha										76	20		2,4-D
												75	30	Endothall
Wapogasset	Polk			70	10								230	2,4-D
							7.2							Endothall
											36.3	463.2	115.8	Endothall
											51	80	27.5	Silvex
											240	100		Diquat
											3.5			Kuron
												4		2,4,5-T
Waterville	Waukesha												204	Endothall
													288	Silvex
Waubesa	Dane												21.6	Endothall
W. Mitchell	Oneida									3.5				2,4-D
White	Langlade									21.6				Endothall
Whitewater	Walworth											64.2	150	Endothall
Wilkie	Manitowoc		40											2,4-D
Willow Springs	Waukesha							14.5						Dalapon
Windfall	Forest												132	2,4-D
Windsor	Dane						21.6							Endothall
Wingra	Dane						18						90.4	Endothall
													125.5	Silvex
White Ash	Polk												120	Diquat
													30	Endothall
													1.7	Endothall
													2.5	Silvex
Wisconsin	Columbia		22											Endothall
Wisconsin R.	Lincoln & Oneida								12	32				Diquat
Wyocena Mill Pd.	Columbia											7.2		Endothall
												160	52	Diquat
												153	113.9	Endothall
												216	160.8	Silvex
Yellow	Burnett										44			Diquat
												10.8	9	Endothall
												15	12.5	Silvex
Yellowstone	Lafayette					30	70	120						2,4-D
Zanders	Green				27.4	30	30	30	30		30	60	30	2,4-D

TABLE 6. Swimmers' Itch Control with Copper Sulphate, 1958-1969.

Lake	County	Pounds Copper Sulphate and Lime											
		1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Antigo Ponds	Langlade							100					
Arrowhead	Waukesha							50					
Balsam	Polk			50	50				100	100	200	200	140
Bass	Oneida			25	25				50	50	100	(100)	(70)
Bear Trap	Polk		40			200							100
Beckman	Green					100							100
Beulah	Walworth					50							(50)
Big Cedar	Washington										300	300	
Big Round	Polk										(150)	(150)	
Black Creek Pd.	Outagamie								300	200	250		300
Bohner's	Racine								150	100	125		100
Bone	Polk								175	190			150
Chetek Chain	Barron								(100)	100			
Deer	Polk										160		
Devil's	Burnett										(80)		
Eau Claire Chain	Bayfield												
Emery	Marquette												
Emily	Florence												
Geneva	Walworth	400	400		1,700*2		500	900	900	720	800	300	400
Half Moon	Eau Claire				250		250	450	450	(350)	(400)	200	(200)
Hunter	Sawyer					100							650
Katrine	Dane	340			260				200				500
Keating	Waupaca	(170)			((130)				(100)				(250)
Klondike Pd.	Sauk						5						150
Long	Fond du Lac												(75)
Mendota	Dane												200
Magnor	Polk												(100)
Metonga	Forest				3,500	3,500		3,000	2,000	2,000	2,200	2,300	275
Mill Bluff Pk.	Monroe				1,750	1,750		1,500	1,000	(1,000)	(1,050)	(1,150)	(100)
Nocquebay	Marinette	1,800	900	1,400		3,200				2,000	2,700	2,300	150
Oconomowoc	Waukesha	900	450	700		1,600				1,000	1,400	1,150	(75)
Pickeral	Portage												(75)
Pike	Polk												2,000
Pine & Grass	Shawano		400	800			1,000		2,100	1,600	1,600	1,200	1,000
Pokegama	Vilas		800	400			500		1,050	800	800	600	1,000
Pokegama	Washburn			300									1,000
				150									500
				300		500	400	600	450	300	200	600	600
				150		100	200	300	225	150	100	300	(200)
						70							100
										200			

TABLE 6 (Cont.)

Lake	County	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
Powers	Kenosha				200				100				
Random	Sheboygan				125								
Rock	Jefferson				100								
Sand	Oneida				50		50						
Sand	Polk						25						
Sandow	Marquette								250				
									125				
Seymour Community	Outagamie										100	350	350
											50	(160)	(200)
												250	
												(125)	
Shawano	Shawano	240	240	240									
		(120)	120	120									
Silver	Forest									400	700		
										(200)	(350)		
S. Twin	Polk		100		100			80		200			
			50		50					200			
Wapogasset	Polk				100	200				100			
					50	88							
Wilson	Shawano	60	100	120									
		(30)	50	60									

TABLE 7. Summary of Aquatic Nuisance Control Activities on Wisconsin Surface Waters, 1970.

No.	Lake	County	Lake Area (Acres)	Treated Area (Acres)	Algae Control (Lbs. CuSO ₄)	Swimmers' Itch Control (Lbs.)	Aquatic Weed Control** Quantity of Chemical
1	Afterglow	Vilas	32	16.00	-	-	800# lime for pH control.
2	Altoona	Eau Claire	783	150.00	1,450 ⁽²⁾	-	-
3	Apple River	Polk	-	0.10	-	-	12# 2,4-D
4	Apple River	Polk	-	0.09	-	-	10# 2,4-D
5	Apple River	Polk	-	2.50	-	-	3 gals. K Endothal & 4 gals. Diquat.
6	Arkdale	Adams	48	12.00	-	-	25 gals. K Endothal & 7 gals. Diquat.
7	Arrowhead	Waukesha	20	-	No Treatment	-	-
8	Balsam	Polk	2,054	0.09	-	-	35# Aqua. +
9	Balsam	Polk	2,054	-	No Treatment	-	-
10	Balsam	Polk	2,054	1.00	-	100 CuSO ₄ 50 lime	-
11	Balsam	Polk	2,054	5.00	-	-	35 gals. Aqua. +
12	Balsam	Polk	2,054	0.34	-	-	80# Aqua. +
13	Balsam	Polk	2,054	9.00	-	-	3 gals. Silvex, 5 gals. K Endothal & 8 gals. Diquat.
14	Balsam	Polk	2,054	0.10	-	-	50# Aqua. +
15	Bass	Burnett	207	0.23	-	-	50# 2,4-D
16	Bear Trap	Polk	244	0.03	-	-	50# Aqua. +
17	Bear Trap	Polk	244	0.06	-	-	50# Aqua. +
18	Beaver Dam	Barron	1,112	120.00	650	-	-
19	Beechwood	Sheboygan	11	10.00	25	-	7 gals. Diquat & 7 gals. K Endothal
20	Beulah	Walworth	837	-	No Treatment	-	-
21	Big Butternut	Polk	378	0.34	-	-	75# Aqua. +
22	Big Butternut	Polk	378	-	No Treatment	-	-
23	Big Butternut	Polk	378	0.46	-	-	1 gal. Diquat
24	Big Butternut	Polk	378	0.11	-	-	100# Aqua. +
25	Big Butternut	Polk	378	-	No Treatment	-	-
26	Big Butternut	Polk	378	74.00	725 ⁽²⁾	-	-
27	Big Cedar	Washington	378	-	No Treatment	-	-
28	Big Roche-A-Cri	Adams	205	70.00	189	-	30 gals. Diquat & 20 gals. 2,4-D
29	Big Round	Polk	1,015	-	No Treatment	-	-
30	Big Round	Polk	1,015	-	No Treatment	-	-
31	Big Sand	Barron	322	-	No Treatment	-	-
32	Big South Pond	Douglas	7	-	No Treatment	-	-
33	Big Wood	Burnett	504	0.50	-	-	50# 2,4-D
34	Birch	Iron	63	-	Denied	-	-
35	Birch	Vilas	528	0.07	-	-	50# Aquathol
36	Birch Island	Burnett	838	3.00	-	-	1 gal. K Endothal & 3 gals. Diquat.
37	Blake	Polk	292	0.11	-	-	50# Aqua. +.
38	Blake	Polk	292	0.09	-	-	25# Aqua. +.
39	Blue	Oneida	433	0.12	-	-	50# Aquathol
40	Bohners	Racine	124	-	No Treatment	-	-
41	Bone	Polk	1,676	0.05	-	-	1 quart Diquat.
42	Bone	Polk	1,676	-	No Treatment	-	-
43	Bone	Polk	1,676	0.17	-	-	20# 2,4-D
44	Bone	Polk	1,676	0.25	-	-	0.5 gal. Diquat.
45	Bone	Polk	1,676	0.23	-	-	0.5 gal. Diquat.
46	Bone	Polk	1,676	0.23	-	-	0.5 gal. Diquat.
47	Bony	Bayfield	200	-	No Treatment	-	-
48	Brandy	Vilas	110	-	No Treatment	-	-
49	Brock Pond	Marinette	28	-	No Treatment	-	-

TABLE 7 (Cont.)

No.	Lake	County	Lake Area (Acres)	Treated Area (Acres)	Algae Control (Lbs. CuSO ₄)	Swimmers' Itch Control (Lbs.)	Aquatic Weed Control** Quantity of Chemical
50	Bugh	Waushara	25	10.00	100	-	-
51	Cadotte	Burnett	127	62.00	-	-	100 gals. Silvex ⁽⁴⁾ & 8 gals. Diquat ⁽²⁾
52	Camelot	Adams	250	58.00	400 ⁽²⁾	-	10 gals. Diquat, 5 gals. K Endothal & 2 gals. Silvex.
53	Camp	Kenosha	461	57.00	-	-	5,750# 2,4-D
54	Catfish	Vilas	991	0.16	-	-	100# 2,4-D
55	Cedar	Manitowoc	142		No Treatment		
56	Cedar Pond	Shawano	3,671		No Treatment		
57	Chetek Chain	Barron	770	300.00	7,150 ⁽⁷⁾	-	-
58	Chetek	Barron	770	0.50	-	-	50# Aqua. +
59	Chetek	Barron	770	3.50	-	-	3 gals. Diquat, 3 gals. K Endothal & 1 gal. Silvex.
60	Chilton Pond	Calumet	10		No Treatment		
61	Chippewa	Bayfield	319		No Treatment		
62	Clam (Upper)	Burnett	1,207	31.00	50	-	17 gals. Diquat ⁽²⁾ , 19 gals. K Endothal ⁽²⁾ , 4 gals. Silvex & 3 gals. Hydrothal 47.
63	Clear	Polk	29	47.00	325 ⁽⁸⁾	-	100# Aqua. +
64	Clear Lake and Pond	Polk	29	5.00	-	-	4 gals. Hydrothal 47.
65	Coleman	Marinette	234	120.00	700	-	-
66	Crawling Stone	Vilas	1,460		No Treatment		
67	Crawling Stone	Vilas	1,460		No Treatment		
68	Crescent	Oneida	612	0.69	-	-	150# Aqua. +
69	Crooked	Sheboygan	65	0.31	-	-	150# Aqua. +
70	Crystal	Columbia and Dane	27		No Treatment		
71	Crystal	Sheboygan	114	70.50	375 ⁽²⁾	-	10 gals. Aqua. +
72	Dallas Pond	Barron	27	8.00	-	-	600# Aqua. +
73	Dana Farm Pond	Kewaunee	0.5		No Treatment		
74	Deer	Polk	807	84.00	400 ⁽²⁾	-	50# 2,4-D, 150# Aqua. + & 12 gals K Endothal.
75	Delavan	Walworth	2,072	360.00	4,095 ^{(8)***}	-	-
76	Delton	Sauk	254	49.00	-	-	5 gals. Aqua. + & 6 gals. Diquat.
77	Devils	Burnett	972	1.00	-	100 CuSO ₄ , 50 lime	-
78	Eagle	Racine	520		No treatment		
79	Eagle Springs	Waukesha	261		No treatment		
80	East Balsam	Polk	2,054	1.00	-	100 CuSO ₄ , 50 lime	-
81	Eau Claire	Eau Claire	860	120.00	600	-	-
82	Elk Creek	Dunn and Eau Claire	46	37.00	200	-	-
83	Elkhart	Sheboygan	300	7.00	-	-	25 gals, 2,4-D
84	Emery	Marquette	35	20.00	310	-	25 gals. Aqua. + & 2 gals. Diquat
85	Emily	Florence	181	4.50	-	300 CuSO ₄ , 150 lime	-
86	English	Manitowoc	48	20.00	100	-	-
87	Fay	Florence	263	4.25	-	-	5 gals. K Endothal, 1 gal. Silvex & 100# Aqua. +
88	Fish	Dane	252	1.00	-	-	2 gals. Aqua. + and 1 gal. 2,4-D
89	Five	Washington	102		No Treatment		
90	Flora Dell	Monroe	6	1.50	-	-	18 gals. P.L.L. ⁽²⁾ , 20 gals. K Endothal & 90# 2,4-D.
91	Fowler	Waukesha	78	17.00	-	-	32.5 gals. Diquat ⁽⁴⁾ & 12 gals. K Endothal ⁽²⁾
92	Geneva	Walworth	5,262	34.50	95 ⁽²⁾	-	600# Aquathol ⁽²⁾
93	Geneva	Walworth	5,262	15.00	-	725 CuSO ₄ ⁽²⁾	

TABLE 7 (Cont.)

No.	Lake	County	Lake Area (Acres)	Treated Area (Acres)	Algae Control (Lbs. CuSO_4)	Swimmers' Itch Control (Lbs.)	Aquatic Weed Control** Quantity of Chemical
94	Geneva	Walworth	5,262	32.40	120 ⁽²⁾	362 CuCO_3	54 gals. K Endothal ⁽²⁾ , 10 gals. Diquat ⁽²⁾ & 50# Aqua. +.
95	George	Kenosha	59	9.50	110 ⁽²⁾	-	2 gals. Aquathol and 2 gals. Diquat in combination (50/50) & 2 gals. K Endothal.
96	Gibbs	Rock	71	3.00	-	300 CuSO_4 150 lime	-
97	Green	Green Lake	7,325		No Treatment		
98	Green Bay	Door	-		No Treatment		
99	Gunlock	Vilas	267		Denied		
100	Half Moon	Eau Claire	132	81.00	3,103 ⁽¹⁰⁾	-	3# CuSO_4 applied as 1 gal. Cutrine.
101	Half Moon	Polk	579	0.05	-	-	10# 2,4-D
102	Halliday Creek	Portage	-		No Treatment		
103	Harris Pond	Marquette	245		No Treatment		
104	Horseshoe	Manitowoc	22	22.00	-	-	23,000# Alum for PO_4 removal.
105	Horseshoe	Manitowoc	22	10.00	75 ⁽²⁾	-	-
106	Horseshoe	Polk	282	0.25	-	-	35# 2,4-D
107	Iola Mill Pond	Waupaca	206	67.00	550 ⁽³⁾	-	40 gals. K Endothal & 5 gals. Diquat.
108	Jerome	Oneida	2		No Treatment		
109	Kawagasaga	Oneida	801	0.17	-	-	100# Aqua. +
110	Kawagasaga	Oneida	801	0.17	-	-	100# Aqua. +
111	Kawagasaga	Oneida	801	0.18	-	-	200# Aqua. +
112	Kawagasaga	Oneida	801	1.03	-	-	350# Aqua. +
113	Keesus	Waukesha	237	50.00	475 ⁽²⁾	-	-
114	Keesus	Waukesha	237	5.00	-	-	1 gal. Diquat and 1
115	LaBelle	Waukesha	1,117	3.00	-	-	180# 2,4-D & 25# Aqua. +.
116	LaBelle	Waukesha	1,117	5.00	-	-	15 gals. 2,4-D
117	LaBelle	Waukesha	1,117	9.75	-	-	20 gals. K Endothal ⁽²⁾ & 60# 2,4-D
118	Lac Court Oreilles	Sawyer	5,040	0.92	-	-	100# 2,4-D
119	Lac Court Oreilles	Sawyer	5,040		No Treatment		
120	Lac Court Oreilles	Sawyer	5,040	0.46	-	-	50# 2,4-D
121	Lauderdale	Walworth	5,262	7.00	-	-	5 gals. Diquat ⁽²⁾
122	Lauderdale	Walworth	5,262	2.00	-	-	4 gals. Diquat
123	Lauderdale	Walworth	5,262		No Treatment		
124	Lauderdale	Walworth	5,262		No Treatment		
125	Lawrence	Marquette	221	20.00	-	-	2,200# Aqua. +
126	Lazy	Columbia	174	27.00	-	-	51 gals. Diquat ⁽²⁾
127	Legend	Menominee	-		No Treatment		
128	Legend No. 1	Menominee	-	100.30	700 ⁽⁵⁾	-	200# Aqua. + 34 gals. Diquat ⁽³⁾ - 12 gals. K Endothal ⁽²⁾ & 5 gals. Silvex.
129	Legend No. 2	Menominee	-	8.40	40	-	4 gals. Silvex
130	Leota	Rock	41	7.50	-	-	8 gals. Diquat
131	Lincoln Park Lagoon	Kenosha	5	3.00	15	-	-
132	Little Blake	Polk	292		No Treatment		
133	Little Blake	Polk	292		No Treatment		
134	Little Cedar	Washington	259	1.25	-	-	5 gals. Diquat
135	Little Elkhart	Sheboygan	50	8.50	25	-	14.5 gals. Aqua. + ⁽²⁾ & 5 gals. K Endothal
136	Little Green	Green Lake	466	44.00	105	-	18 gals. Diquat.
137	Little Long	Manitowoc	15	11.00	60	-	-

TABLE 7 (Cont.)

No.	Lake	County	Lake Area (Acres)	Treated Area (Acres)	Algae Control (Lbs. CuSO ₄)	Swimmers' Itch Control (Lbs.)	Aquatic Weed Control** Quantity of Chemical
138	Little Muskego	Waukesha	506	14.00	50	-	5 gals. Diquat & 2 gals. Aqua. +.
139	Little Muskego	Waukesha	506	3.00	-	-	5 gals. Aqua. +
140	Little St. Germain	Vilas	956	350.00	1,450	-	-
141	Little Wood	Burnett	185	0.07	-	-	1 gal. Diquat
142	Little Wood	Burnett	185	0.25	-	-	1 gal. Diquat
143	Long	Columbia	39	15.00	-	-	30 gals. Diquat
144	Long	Iron	373	-	No Treatment	-	-
145	Long	Manitowoc	117	80.00	1,450 ⁽⁴⁾	-	-
146	Long	Polk	257	197.00	1,000 ⁽²⁾	-	13 gals. Aqua. +
147	Long (Channel)	Fond du Lac	409	-	No Treatment	-	-
148	Long	Washburn	3,290	-	No Treatment	-	-
149	Long Trade	Polk	257	40.00	200	-	-
150	Loon	Burnett	189	-	No Treatment	-	-
151	Lost	Vilas	541	-	No Treatment	-	-
152	Loveless	Polk	123	0.14	-	-	30# Aqua. +
153	Lower Eau Claire	Bayfield	-	-	No Treatment	-	-
154	Lower Genessee	Waukesha	66	0.07	-	-	12 ounces Diquat
155	Lower Phantom	Waukesha	433	41.00	85.5 ^{(3)***}	-	900# Aqua. + ⁽²⁾ , 20 gals. K Endothal, 22.5 gals. Diquat & 8 gals. Diquat and 8 gals. Cutrine in combination.
156	Lynxville	Crawford	-	-	No Treatment	-	-
157	Magnor	Polk	224	2.30	75	200 CuSO ₄ 100 lime	-
158	Manawa Mill Pond	Waupaca	192	2.00	-	-	3 gals. Diquat
159	Marinuka	Trempealeau	110	14.00	50	-	6 gals. Diquat & 6 gals. K Endothal
160	Mathews	Washburn	268	-	No Treatment	-	-
161	McDill Pond	Portage	262	13.50	-	-	24.5 gals. K Endothal, 12.5 gals. Diquat ⁽²⁾ , & 150# Aquathol.
162	Mendota	Dane	9,730	188.52	-	-	310 gals. K Endothal & 900# Aqua. +.
163	Menomin	Dunn	1,405	160.00	3,780 ⁽⁷⁾	-	-
164	Menomonee Park Quarry	Waukesha	-	-	No Treatment	-	-
165	Mercer	Oneida	253	50.00	200	-	-
166	Metonga	Forest	2,157	-	No Treatment	-	-
167	Mid	Oneida	215	23.00	-	-	1,500# Aquathol & 800# 2,4-D.
168	Middle Eau Claire	Bayfield	804	-	No Treatment	-	-
169	Middle Lauderdale	Walworth	259	3.00	-	-	3 gals. Diquat
170	Mill	Walworth	271	-	No Treatment	-	-
171	Mill	Walworth	271	0.86	-	-	150# Aqua. +
172	Mill	Walworth	271	-	No Treatment	-	-
173	Minocqua	Oneida	1,258	4.60	-	-	350# Aqua. +
174	Minong Flowage	Douglas	-	0.50	-	-	½ gal. 2,4-D
175	Minooka Park Pond	Waukesha	-	-	No Treatment	-	-
176	Monona	Dane	3,335	22.25	3	-	125 gals. Aqua. +, 700# Aqua. + & 90 gals. K Endothal ⁽²⁾
177	Montello	Marquette	286	30.00	-	-	55 gals. Diquat ⁽²⁾
178	Muellers	Washington	10	-	No Treatment	-	-
179	Mukwonago Park Pond	Waukesha	1.0	1.00	6***	-	-
180	Muskego Park Pond	Waukesha	2.0	2.00	11.5	-	6# CuSO ₄ applied as 2 gals. Cutrine.
181	Nagawicka	Waukesha	917	-	No Treatment	-	-
182	Nagawicka	Waukesha	917	100.00	1,930 ⁽⁴⁾	-	-
183	Nagawicka	Waukesha	917	-	No Treatment	-	-

TABLE 7 (Cont.)

No.	Lake	County	Lake Area (Acres)	Treated Area (Acres)	Algae Control (Lbs. CuSO ₄)	Swimmers' Itch Control (Lbs.)	Aquatic Weed Control** Quantity of Chemical
184	Nakoma Golf Pond	Dane	1.1		No Treatment		
185	Nepco	Wood	494	215.00	1,900	-	4,050# Aqua. +
186	Noquebay	Marinette	2,162		No Treatment		
187	North Pond	Marinette	74		No Treatment		
188	North Twin	Polk	135		No Treatment		
189	North Twin	Polk	135	0.75	-	-	1 gal. K Endothal & 1 gal. Diquat.
190	O'Brien Springs	Langlade	-		No Treatment		
191	Oconomowoc	Waukesha	767	44.00	225 ⁽²⁾ ***	1,060 CuSO ₄ 500 lime	15 gals. K Endothal, 15 gals. 2,4-D & 2 gals. Diquat
192	Okauchee	Waukesha	1,187		No Treatment		
193	Okauchee	Waukesha	1,187	106.90	333 ⁽⁴⁾ ***	-	11.5 gals. Diquat, 16 gals. K Endothal & 270# 2,4-D used in combination with Cutrine.
194	Onalaska	La Crosse	8,000	6.00	25 ⁽²⁾	-	8 gals. K Endothal
195	Paddock	Kenosha	112	69.00	120***	-	115 gals. 2,4-D ⁽²⁾ & 4 gals. K Endothal.
196	Paquette Park Pond	Columbia	1.3		No Treatment		
197	Paquette Park Pond	Columbia	1.3	1.30	5.25***	-	2 gals. Diquat
198	Park	Columbia	219	55.00	200	-	33 gals. Aqua. +
199	Pearl	Waushara	101		No Treatment		
200	Pelican	Oneida	3,585		No Treatment		
201	Perch	Monroe	32	12.00	-	-	40 gals. K Endothal & 7.5 gals. Diquat.
202	Peshtigo Mill Pond	Marinette	460	4.50	-	-	3 gals. Diquat & 5 gals. Aqua. +.
203	Peters Lake	Walworth	64		No Treatment		
204	Pewaukee	Waukesha	2,493	90.00	1,475 ⁽⁴⁾	-	-
205	Pewaukee	Waukesha	2,493	39.50	90***	240 CuSO ₄ 120 lime	5 gals. K Endothal & 15 gals. 2,4-D
206	Pickeral	Walworth	30	0.18	-	-	4 gals. 2,4-D
207	Pickeral	Portage	52	10.00	50	-	-
208	Pike	Marathon	208	85.00	750 ⁽²⁾	-	1,000# Aqua. +
209	Pike	Marathon	208	1.00	-	-	75# Aqua. +
210	Pike	Marathon	208	0.46	-	-	50# Aqua. +
211	Pike	Polk	148	0.06	-	-	50# Aqua. +
212	Pike	Kenosha	-		No Treatment		
213	Pine	Polk	82	0.11	-	-	20# 2,4-D
214	Pine	Polk	82	0.34	-	-	10# 2,4-D
215	Pine and Grass	Shawano	209	17.00	-	1,700 CuSO ₄ 850 lime	-
216	Pine	Waukesha	703		No Treatment		
217	Pine	Waukesha	703	50.00	-	-	25 gals. K Endothal, 105 gals. 2,4-D & 660# 2,4-D
218	Pioneer	Vilas	415		No Treatment		
219	Plymouth	Sheboygan	36	8.00	35	-	5 gals. Diquat & 5 gals. K Endothal
220	Pokegama	Washburn	453	-	-	450 CuSO ₄ 225 lime	50# Aqua. +, 1 gal. Silvex & 4 gals. K Endothal
221	Ponds	Iowa	-		No Treatment		
222	Potters	Walworth	162	29.00	-	-	1,050# Casaron, 55 gals. K Endothal & 5 gals. Diquat.
223	Prairie	Barron	1,534		No Treatment		
224	Pretty	Waukesha	64	0.24	-	-	50# Aqua. +
225	Pretty	Waushara	15		No Treatment		
226	Private Pond	Ozaukee	0.5	0.75	-	-	2# Karamex
227	Pue's Pond	Waupaca	-	1.00	-	-	200# Aqua. +
228	Redstone	Sauk	600		No Treatment		
229	Redstone	Sauk	600	100.00	2,200 ⁽⁷⁾	-	-

TABLE 7 (Cont.)

No.	Lake	County	Lake Area (Acres)	Treated Area (Acres)	Algae Control (Lbs. CuSO_4)	Swimmers' Itch Control (Lbs.)	Aquatic Weed Control** Quantity of Chemical
230	Rice	Barron	828	8.00	-	300 CuSO_4 150 lime	1 gal. Silvex, 5 gals. Diquat & 5 gals. K Endothal
231	Round	Waushara	63	0.30	-	-	50# Aqua. +
232	Round	Burnett	203	80.00	900(3)	-	-
233	Sand	Barron	322	-	No Treatment	-	-
234	Sand	Polk	187	-	90(2)	-	8 gals. Diquat
235	Sandow	Marquette	19	7.00	-	400# CuSO_4 200 lime	10 gals. K Endothal & 100# Aquathol.
236	Schnurs	Price	146	0.09	-	-	5# Aquathol
237	Seymour Community	Outagamie	3	3.50	-	300 CuSO_4 150 lime	-
238	Shangri-La	Kenosha	154	-	No Treatment	-	-
239	Shangri-La	Kenosha	154	28.50	195(2)***	-	56 gals. Diquat & 40 gals. K Endothal
240	Shattuck	Chippewa	59	0.50	-	-	50# Aquathol
241	Shawano	Shawano	6,178	126.45	300	-	63 gals. Diquat, 192 gals. K Endothal & 50# Hydrothal 47.
242	Sherwood	Adams	250	30.50	250(2)	-	10 gals. K Endothal & 5 gals. Diquat.
243	Shishebogama	Oneida	716	-	No Treatment	-	-
244	Shoal	Burnett	247	-	No Treatment	-	-
245	Silver	Columbia	52	-	No Treatment	-	-
246	South Twin	Polk	74	2.00	-	200 CuSO_4 100 CuCO_3	200# Aqua. +
247	South Twin	Polk	74	-	No Treatment	-	-
248	Spalding Mill Pond	Rock	28	-	No Treatment	-	-
249	Spring Bank	Monroe	10	4.50	12	-	9 gals. P.L.L.
250	Spring	Columbia	17	-	No Treatment	-	-
251	Sturgeon Bay	Door	-	0.01	-	-	20# Aqua. +
252	Squaw	St. Croix	129	80.00	500(2)	-	-
253	Swan	Columbia	419	-	No Treatment	-	-
254	Swift	Walworth	19	0.41	-	-	1 gal. 2,4-D & 1 gal. Diquat.
255	Tarrant	Columbia	18	-	No Treatment	-	-
256	Teal	Sawyer	1,049	-	No Treatment	-	-
257	Thorn	Portage	17	0.25	-	-	50# Aqua. +
258	Tichigan	Racine	891	12.00	50	-	5 gals. Aqua. +
259	Tichigan	Racine	891	0.33	-	-	3.5 gals. Aqua. +
260	Tomah	Monroe	243	120.25	1,250(2)	-	0.5 gals. Silvex
261	Trade	Burnett	432	80.00	400	-	-
262	Troy Mill Pond	Walworth	20	5.00	-	-	3 gals. Diquat
263	Upper Nemahbin	Waukesha	283	7.00	105***	-	-
264	Upper Nemahbin	Waukesha	283	6.08	54(2)***	-	300# Aqua. + 1.5 gals. Diquat
265	Upper Phantom	Waukesha	106	4.75	18(2)***	-	1 gal. Diquat, 117# Aqua. + & 4 gals. K Endothal
266	Verona Park Pond	Dane	8	-	No Treatment	-	-
267	Voltz	Kenosha	52	3.00	-	-	10 gals. K Endothal
268	Wallace	Washington	50	-	No Treatment	-	-
269	Wallace	Washington	50	15.00	135***	-	-
270	Wapogasset	Polk	1,186	195.00	4,800(7)	-	3 gals. Hydrothal 47 & 20 gals. P.L.L.
271	Wapogasset	Polk	1,186	0.03	-	-	50# Aquathol
272	Waubesa	Dane	2,113	1.00	-	-	150# Aqua. +
273	West	Columbia	19	2.80	-	-	20 gals. Aqua. +
274	White Ash	Polk	144	33.50	75	-	14.5 gals. K Endothal & 17.5 gals. Diquat.
275	Whitewater	Walworth	640	119.00	1,500(3)	-	45 gals. K Endothal(2)
276	Willow Creek Game Reserve	Washington	-	9.00	-	-	27# Karmex
277	Windfall	Forest	56	14.00	115(2)	-	15 gals. Diquat
278	Wingra	Dane	345	5.00	-	-	1,000# Aqua. +

TABLE 7 (Cont.)

No.	Lake	County	Lake Area (Acres)	Treated Area (Acres)	Algae Control (Lbs. CuSO_4)	Swimmers' Itch Control (Lbs.)	Aquatic Weed Control** Quantity of Chemical
279	Winnebago	Winnebago	137,708		No Treatment		
280	Winnebago	Winnebago	137,708		No Treatment		
281	Wisconsin	Columbia	9,000		No Treatment		
282	Wisconsin	Columbia	9,000	5.00	60***	-	-
283	Wisconsin	Columbia	9,000		No Treatment		
284	Wyocena Mill Pond	Columbia	90	21.00	-	-	42 gals. Aqua. +
285	Yellow River	Barron	-	5.00	-	-	1,550# Aqua. +
286	Yellow	Burnett	2,287	0.44	-	-	15# 2,4-D
287	Yellow	Burnett	2,287	0.23	-	-	50# Aqua. +
288	Yellow	Burnett	2,287		No Treatment		
289	Yellow	Burnett	2,287	89.00	1,575 ⁽⁴⁾	-	4 gals. Diquat & 4 gals. K Endothal
290	Zoo Pond	Racine	1.5		No Treatment		

DEPARTMENT OF NATURAL RESOURCES PROJECTS - 1970

1	Beckman	Green	-	3.50	-	300 CuSO_4 150 lime	-
2	Mill Bluff Park Pond	Monroe	3	3.00	-	150 CuSO_4 75 lime	12# Dalapon
3	Nancy	Bayfield	7		No Treatment		
4	Storr's	Rock	40		No Treatment		

* Number of chemical applications given in parentheses

** Aqua. + = Aquathol +

*** Chelated Copper (applied as Cutrine, 3# CuSO_4 per gal.)

K = Potassium

pH Control (to increase productivity)

800 lbs. Lime

Nutrient Removal (to remove PO_4)

23,000 lbs. Alum

Swimmers' Itch Control

6,925 lbs. CuSO_4 (100% active)462 lbs. CuCO_3 2,970 lbs. Lime³

Algae Control

53,670.25 lbs. CuSO_4 (100% active)

1,050 lbs. Casaron

47 gals. P.L.L.

Higher Plant Control

16,957 lbs. Aqua. + (contains 3.6% Endothal Acid + 5% Silvex Acid)

2,255 lbs. Aquathol (contains 7.2% Endothal Acid)

342 gals. Aqua. + (contains 1.7 lbs. Endothal Acid + 2.4 lbs. Silvex Acid per gal.)

2 gals. Aquathol "K" (contains 1.46 lbs. Endothal Acid per gal.)

1,218 gals. Potassium Endothal (contains 4.23 lbs. Endothal Acid per gal.)

675.3 gals. Diquat (contains 2 lbs. of Diquat Cation per gal.)

122.5 gals. Silvex (contains 4 lbs. Active per gal.)

344.5 gals. 2,4-D (contains 4 lbs. Active per gal.)

8,372 lbs. 2,4-D (20% active)

12 lbs. Dalapon (85% active)

29 lbs. Karamex (80% active)

7 gals. Hydrothal 47 (contains 1.5 lbs. Active per gal.)

50 lbs. Hydrothal 47 (contains 5% Endothal Acid)

TECHNICAL BULLETINS

Currently Available From the Department of Natural Resources

- No. 10 Role of Refuges in Muskrat Management. (1954) Harold A. Mathiak and Arlyn F. Linde
- No. 11 Evaluations of Stocking of Breeder Hen and Immature Cock Pheasants on Wisconsin Public Hunting Grounds. (1955) Cyril Kabat, Frank M. Kozlik, Donald R. Thompson and Frederic H. Wagner
- No. 13 Seasonal Variation in Stress Resistance and Survival in the Hen Pheasant. (1956) Cyril Kabat, R. K. Meyer, Kenneth G. Flakas and Ruth L. Hine
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The author is Chief of Laboratory Services, Bureau of Standards and Surveys.

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